Power and The Engineer

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IT has been solemnly stated that once a week is too frequent for the visitations of POWER. Fifteen or twenty years ago there might have been some ground upon which to base this assertion. However, the remarkable progress which has been made during the last decade or two in all branches of the science of power has served to remove all grounds for objections to a weekly power paper.

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When journalism was in its swaddling clothes the proper frequency of publication was about once a month. The editions usually consisted of about four pages, say, eight by fourteen inches in size. The size and the interval exactly fitted the times. News could only be gathered by stage coaches. But even if it could have been accumulated by more expeditious means it would have taken so long to set it in type and print it that the news would still be stale. Furthermore, transportation being difficult, people did not move often or far; hence, except in the cases of a few national events, such as a war, news items had very little other than local value.

Imagine, please, a newspaper of today which contained only four pages a little larger than a postage stamp in size and which appeared only once a month. Such a paper would be a farce.

Cheap and comfortable transportation coupled with cheap means of quick communication has served to diffuse the population and amalgamate its interests, so that many otherwise purely local events are of widespread interest and have real news value. Great progress in the mechanical sciences has made the speed of publication keep pace with the demands of the times. As a result we have great daily newspapers which issue anywhere from four to ten editions a day.

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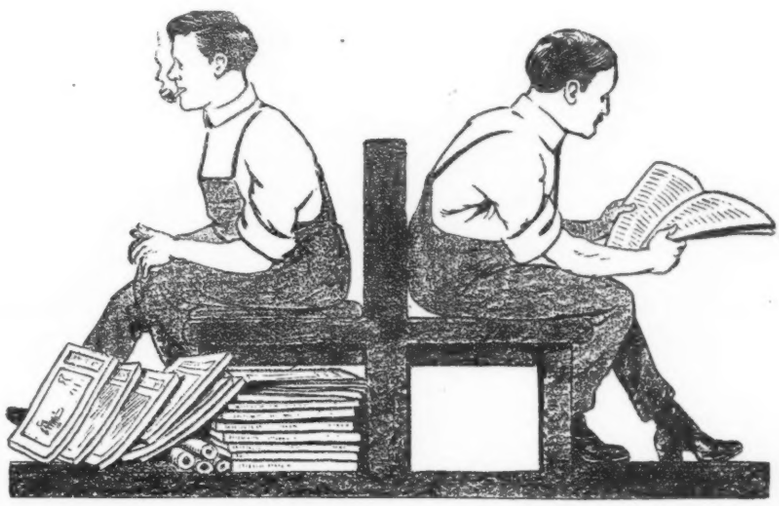

A very similar development has taken place in the power field.

You can easily figure out how long a power paper would have lasted in the time of Watt. About as long as a snowball in a furnace. There was no practical field for such a paper then, and, consequently, no demand. Even a paper which came out only once a year would have been superfluous.

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About 30 years ago, when electricity was still in its inception, a paper devoted to steam engineering was brought out to meet an embyro demand for news and information relative to the science of power generation. It was issued once a month. The average edition contained about ten reading pages. There was no need for more for the field was not large, judged by the standard of today, and practically only steam and water power were used.

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But, today, with the vast application of power in a great variety of forms, the field is enormous and progress is rapid. Of necessity the engineer of today must know far more than the engineer of those days. He must keep pace with the times.

To do this the one best way available is to follow the current literature which deals with the latest achievements, tells of what is being done and how.

The progressive man devours all the information he can get and, like Oliver Twist, wants more. To him the weekly consignment is most welcome.

The weekly idea is good for the less ambitious, too. As it comes in homeopathic doses he is likely to retain some each week and in the end have more than if his "medicine" were administered in such large monthly potions as to discourage him completely. In other words, he is less liable to get mental indigestion.

Equipment of the Blackstone Hotel

By Osborn Monnett

Owing to the unusually small area covered by this hotel in proportion to its hight, special attention had to be given to the layout of the power plant in order to insure an equipment which, although complete in every respect, would require as little floor space as possible. Elaborate systems of refrigeration and ventilation have been installed and a complete record is kept of operating details.

One of the latest architectural additions to Chicago's downtown district is the Blackstone hotel, situated at Michigan avenue and Hubbard court. This structure is twenty-three stories high, and unusual attention has been paid to the exterior decorations, with the interior appointments in keeping with the impression gained from the outside.

The ground space is unusually restricted for a building of such hight, necessitating much ingenuity in the layout of the mechanical plant, which is of the most complete character. The foundation measures only 80 feet on Michigan avenue by 173 feet on Hubbard court, the building resting on thirty-four caissons, each 11 feet in diameter, filled with concrete and sunk 100 feet to bed rock. These caissons are tied together by interlocking concrete-covered steel beams, forming the foundation into one solid supporting structure, but making the problem of suitable foundations for the machinery a very difficult one. Owing to the restricted space available, all the equipment has been placed in one room, the boilers, engines, pumps and other auxiliary machinery having been placed as close together as possible and still allow room for convenient operation. The ground-floor plan, shown in Fig. 1, indicates to some extent the compactness of the installation.

The coal, which is delivered in wagons at the Hubbard court side of the building, is discharged into a bin which is located under the sidewalk, and which has a capacity of 175 tons. Facing this coal bin are the boilers, four in number, each of the Stirling type and rated at 250 horsepower. They are set separately with a building column between each setting. Each boiler is equipped with a McKenzie chain-grate stoker, driven by an individual 1½-horsepower motor. Fig. 2 is a front view of the boilers, showing the stokers. Coal from the storage bin is fed to a one-ton Howe traveling, weighing hopper, which distributes it to the stokers as required. The uptakes from the boilers pass over the engine cylinders to the steel stack which is located in the northwest corner of the building. The stack is oval in section, and extends to a hight of 328 feet above the grates.

Williams feed-water regulators are fitted to the boilers and the feed lines, which are of extra-heavy pipe, are entirely in duplicate up to the point where the feed enters the rear upper drum. There are two 12 and 7½ by 12-inch Marsh boiler-feed pumps and, in addition, it is possible to feed the boilers by means of four 12x16x9¼x16-inch tandem - compound American pumps which are ordinarily used to supply water for general purposes. The feed water passes through a Venturi meter before entering the boilers, the indicating and recording gages being located in the engineer's office.

The ashes are removed to a storage bin, located under the alley at the back of the hotel, by means of a pan conveyer; from there they are elevated to wagons and carted away.

The hydraulic-elevator equipment consists of two 12x20x11x20-inch American tandem-compound pumps, delivering water into a compression tank at 120 pounds pressure. This pressure supplies the motive power for one sidewalk hoist with a lift of 20 feet, one kitchen elevator, with a lift of 66½ feet, and one ball-room elevator with a 48-foot lift, all operating at a speed of 200 feet per minute. A general view of these pumps is shown in Fig. 3.

Piping

Leading from each boiler there is a 6-inch and a 4-inch steam header, each

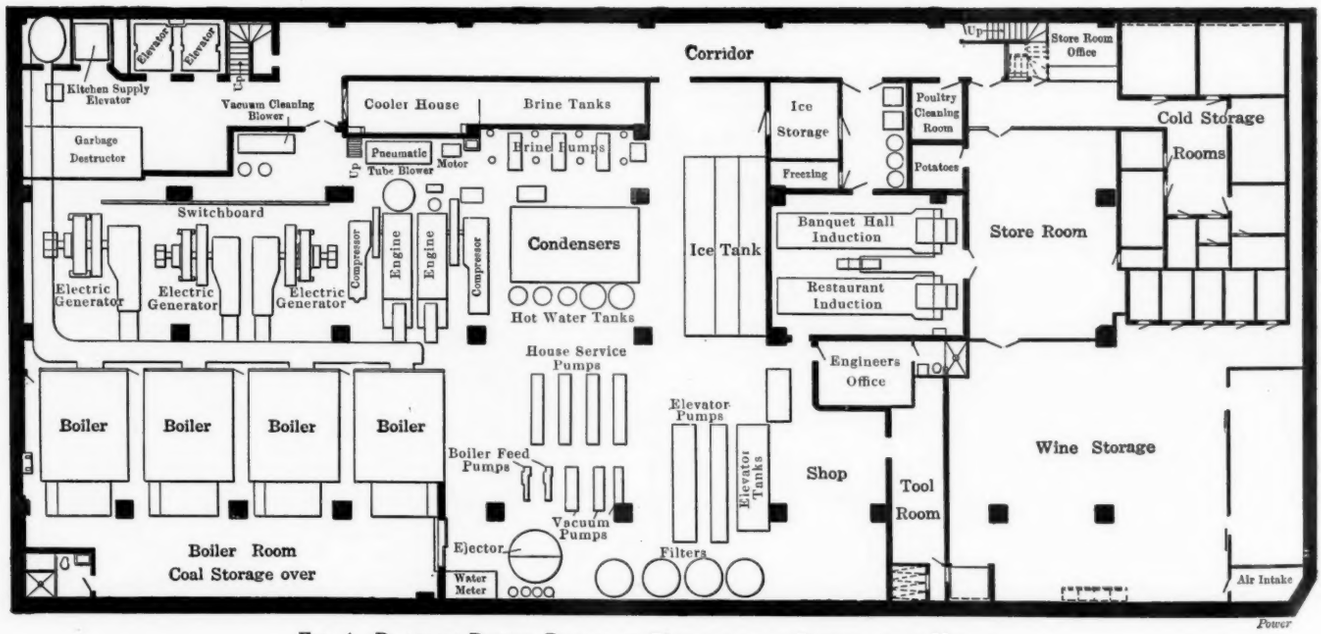


FIG. 1. PLAN OF POWER PLANT IN BASEMENT OF BLACKSTONE HOTEL

engines and the branches from each boiler drop into this. From the top of this header the leads rise to the various engines, and a separator is fitted above each throttle valve. All high-pressure piping is extra-heavy with welded flanges, and Nelson valves are used on all high-pressure steam lines. Morehead tilting traps take care of the condensation on both the high- and the low-pressure piping.

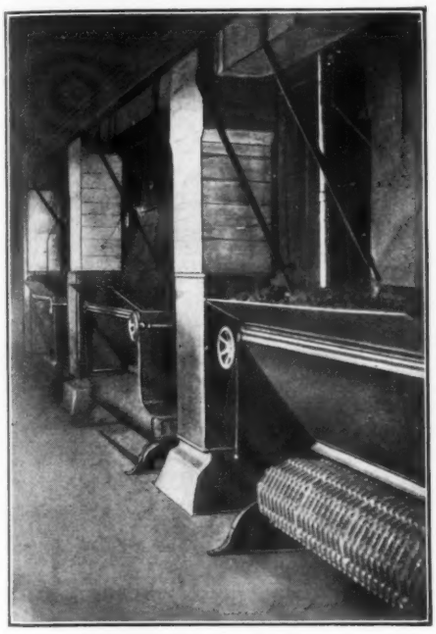


FIG. 2. BOILER ROOM

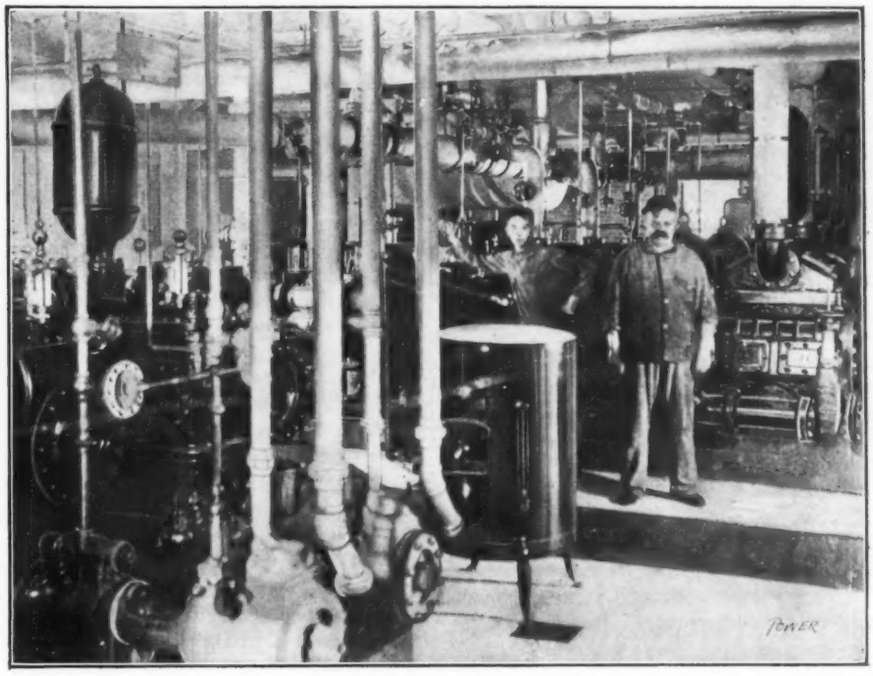


FIG. 3. PUMPING EQUIPMENT OF BLACKSTONE PLANT

ENGINES AND GENERATORS

The engines are arranged in a row directly behind the boilers and as close to them as is possible with allowable room for taking out the pistons. Fig. 4 gives a comparative idea of the distance between the cylinder heads and the backs of the boilers. There is one 22x27-inch Ball four-valve engine connected to a 300-kilowatt generator and two 18x27-inch Ball four-valve engines, each connected to a 200-kilowatt generator. Each engine is fitted with an individual gravity oiling system, the pump for which is operated from an extension arm on the crank pin of the engine. Richardson-Phœnix force-feed pumps supply oil to the cylinders, the oil being introduced at two different points over the steam valves.

The generators are all of the Western Electric Company type and deliver current on the three-wire system at 220 volts for the power circuits and 110 volts for the lighting circuits. The switchboard consists of thirteen panels of Tennessee marble and is 34 feet long. The current is measured on the power panels as it comes from the generators and is also measured at the individual power and lighting panels. The feeders are protected by double-pole circuit-breakers and there are no switches on the board, the circuit-breakers serving this purpose. The power is used to run four passenger and two service elevators of the Otis type, laundry and kitchen motors, motors driving the ventilating fans, the machine shop, and the centrifugal pumps; besides this there are a number of motors for various purposes, making from 75 to 80 motors installed. There are about 9000 lamps in use, and the average electrical load for the month of August amounted to 3530 kilowatt-hours per day.

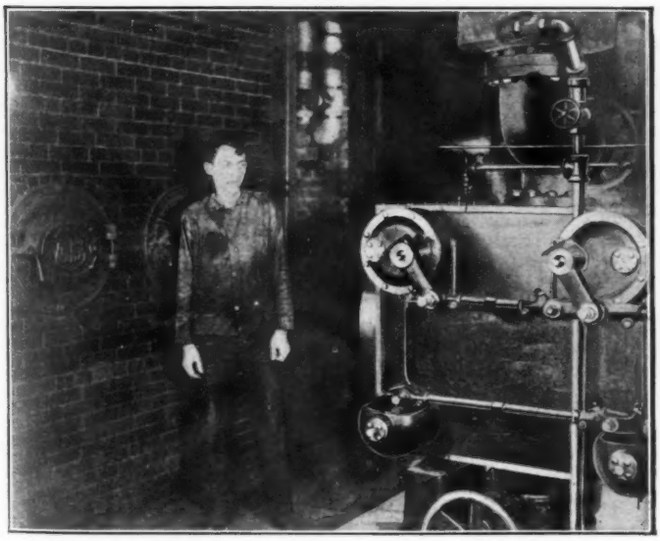


FIG. 4. SHOWING CLEARANCE SPACE BETWEEN ENGINES AND BOILERS

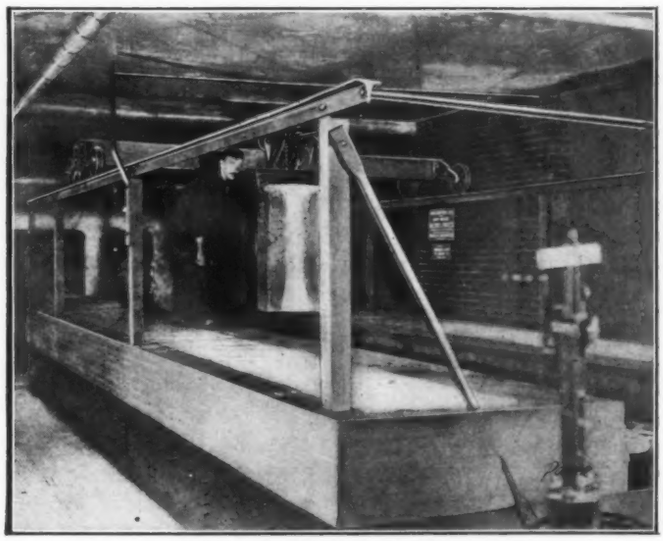


FIG. 5. HARVESTING PLATE ICE MADE BY THE JEWELL SYSTEM

Exhaust Heating System

A 16-inch exhaust main extends under the floor to a point near the stack, from which point all of the exhaust steam for heating the building is controlled. A 16-inch exhaust riser extends to the roof and terminates in a Swartwout exhaust head; a 16-inch back-pressure valve is also located in this line and the heating is accomplished on the up- and down-flow system. A 12-inch heating main carries the steam to the upper floors where it divides into two 8-inch branches from which the steam flows down to the radiators in the various rooms, supplying in this way a total of 35,000 square feet of direct radiation. The returns are handled by the vacuum-return system for which purpose three Marsh pumps are installed in the basement and maintain a vacuum of about 7 inches. A live-steam connection is supplied to aid the heating system in case of a scarcity of exhaust steam. By this means the steam passes first through a Collins reducing valve which reduces the pressure from 150 to 50 pounds and then passes through a 12-inch Locke hydrostatically operated reducing valve, which delivers the steam at one pound pressure. Live steam is also stepped down through Collins reducing valves to 80 pounds for use in the laundry and to 30 pounds for use in the kitchen. Connected to the exhaust system is one Wainwright feed-water heater for the boilers and three Baragwanath heaters for the house service, the latter being controlled by a thermostat which maintains a temperature of about 150 degrees Fahrenheit.

Refrigerating Equipment

Among the important features of the equipment are two Kroeschell carbon-dioxide ice machines, one an 80-ton machine used for cooling the air supply to the various public rooms, and the other of 50 tons capacity, used for making ice and cooling various ice boxes throughout the building. The compressors are of the regular CO_2 type, operating in conjunction with a double-pipe condenser and are driven by Murray engines. In the former service air is taken at a point 60 feet above the street and is conducted to the basement where it is passed through coils which heat it to 45 degrees in the winter, and thence through a water spray which removes any impurities. In the summer time the air is then passed through the cooling coils and finally through the eliminator, which removes all excess moisture, thence to the various public rooms in which a predetermined temperature is maintained. On one of the hottest days during the past summer, with the outside air at 106 degrees, the public rooms of the hotel were maintained at a temperature of 74 degrees without trouble.

The 50-ton ice machine cools an elaborate system of ice boxes in the kitchen, service pantries and basement. In addition to this service, eight tons of ice is made daily on the Jewell system, that is, making plate ice in cans. This is one of the first installations of its kind and is worthy of some attention. With this system it is feasible to make clear ice without distilling or reboiling the water, and freeze 400-pound cakes within 24 hours with brine at about zero degrees.

The cans are provided with a jacket around which the brine circulates, and in the bottom of each can there is a non-freezing zone consisting of a shallow rectangular pocket in which is introduced a jet of refrigerated air. This keeps the water agitated at this point and any impurities are deposited here. When the cakes are frozen the jet of air, which is supplied at very low pressure, is autocatically shut off by the ice. In harvesting, the supply of brine, which is handled by a 6-inch motor-driven centrifugal pump, is shut off from the brine cooler and circulates through a coil in a tank containing the water for the next freezing; this cools the water and warms the brine, thereby thawing the ice from the cans. The new supply of water is fed to the ice cans through a float-regulating valve so that when the ice is loosened in the can it floats and the can is automatically filled with fresh water after the cake has been removed. A compressed-air hoist handles the ice and delivers it to the store room, as shown in Fig. 5. This system of precooling the fresh water and using the heat given up by the water to thaw the ice from the cans, utilizes heat which is ordinarily wasted and is said to about balance the loss occasioned by the introduction of refrigerated air into the bottoms of the cans.

Water System

The building is supplied by two 6-inch mains in which Worthington turbine meters are installed. All water for the building passes through International quartz filters before being used and then passes to the feed pumps, house pumps, etc. In addition to passing through these filters, the water used for drinking and freezing is again filtered in International disk filters. Water for house use is supplied on a high- and medium-pressure system. The high-pressure system consists of a tank on the roof supplied direct by one of the house pumps under a static pressure of approximately 135 pounds; from this tank the water is distributed to the different floors of the building down to and including the seventh floor. Hot water for the high-pressure system is supplied from this tank and passes through one of the Baragwanath heaters. The medium-pressure system is supplied by one of the house pumps at 90 pounds pressure, the pump delivering into an expansion tank located on the line. This system supplies both hot and

THE BLACKSTONE
THE DRAKE HOTEL CO., Props.
ENGINE ROOM DAILY RECORD

Date _____

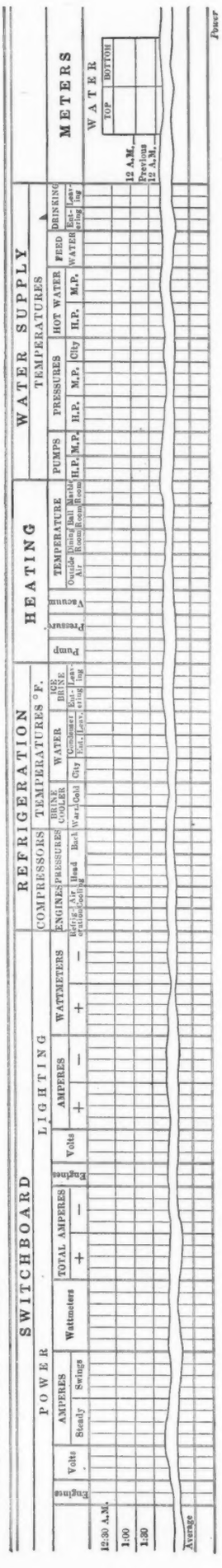


Fig. 6. Daily Record Sheet Upon Which Readings Are Entered Every Half Hour

cold water from the ground floor up to and including the sixth floors. For the basement floors city-water pressure is relied upon.

System of Records

A complete record is kept of all operating details, the daily report blank of which is shown in Fig. 6. The daily totals are then posted on a monthly report sheet which gives a complete record of the month's run in such shape that a clear idea may be had of the character of the service in every department.

In every large office building or hotel the manner of handling complaints is of great importance. Frequently it is necessary for the protection of the engineering department that a proper record of these complaints be kept and it is also a satisfaction to the management to know, just what has been done and who is responsible. In the case of the Blackstone hotel there has been worked out a very satisfactory scheme by which complaints are handled. Complaints are received at the engineers' office by telephone, verbally, by means of the telautograph, or by written messages through the pneumatic-tube service. When a complaint is received the name of the person making the complaint is entered on the sheet with a complete description of the difficulty and the name of the workman to whom the repairs are delegated. This sheet is then stamped with the chief engineer's name and the time received, and the other half of the sheet is delivered to the workman with a description of the job to be done, and whom to see in regard to it. All the material used on the job is entered and the time noted when the work is completed. This is then signed by the workman and delivered to the chief engineer's office. The two portions of the sheet bear the same serial number and are filed together, constituting a complete record of the transaction.

Stopping a Troublesome Pound

By R. O. Warren

A dull, heavy pound occurring once in every dozen revolutions puzzled the engineer for a number of days. He was at his wits' end when a friend stepped in and by mere chance located the trouble.

I had finished a long, hot, twelve-hour run, such as befalls the lot of most central-station operating engineers, and was on my way home, when I heard a call coming from the direction of the King Cycle Manufacturing Company.

I stopped and spied George Hicky swinging his arms like a windmill as he beckoned me to come over to his engine room.

"Did you ever have a pound, a pound that was out of step with everything about the engine?" he asked, before I had a chance to speak.

"Come on in," he exclaimed, as he grabbed me by the coat sleeve. "I'm all befuddled and about as near crazy as I ever will be. I've had a pound in my engine for about a week and can't locate it. I'm ——"

"Now go slow," said I, "and let's take things easy. Have a cigar, and just rest yourself in your old soft-seated chair. That cigar will soothe your nerves." When we had gotten our cigars going, he began again.

"It's the dundest thing I've ever run up against. I had an idea that I could find a pound in an engine about as quick as the next one, but this one has got me stumped. My night engineer is as much puzzled as I, and both of us have been hunting that pound, day and night, for a week. Listen—did you hear that?"

I did; there was no mistaking the dull, heavy thud that occurred at regular intervals, but at no particular point of the engine stroke. In fact, the engine would make about a dozen revolutions before the pound would be repeated. This made the matter all the more puzzling and might have baffled my friend for a few days more if the cause had not been discovered by chance.

We had left our chairs and I was standing facing the cylinder on the flywheel side of the engine. Fortunately, I happened to look at the flywheel when it appeared to move sideways, accompanied by the thud that had been causing so much worry. Keeping my eyes fixed on the flywheel, I waited until the thud was repeated, which was accompanied by a side movement of the flywheel.

A close examination disclosed the fact that the eccentric and distance collar that was placed on the shaft between the eccentric and the main pillow block had worked over on the shaft about ¼ inch. Every so often the shaft would work into its proper place with the crank against the pillow block. The shaft would run in this position for a time and would then slide through the bearing until the collar and eccentric brought it up with a thud.

When the engine was shut down for oiling ready for the night run, a piece of scantling was brought to bear on the rim of the flywheel, with one end in the wheel pit. While George shut down, the oiler bore against the outer end of the scantling and forced the shaft over in the bearings so that the crank came against the pillow block. The eccentric was then moved over on the shaft and secured in that position. When the engine was started up the pound had disappeared and so far as I know has never returned.

As the Engine Slowed Down, the Fireman Utilized His Strength on a Scantling

As I started out of the engine room George remarked, "It don't take much to keep a man guessing, does it?"

The Zeuner Valve Diagram

By W. J. Harden

A convenient and simple means of studying the relative positions of the valve and main crank during one revolution is offered by the Zeuner diagram. This is familiar to many, but for the benefit of those who have never used it, or those whose conception of it is hazy, a simple explanation is presented.

The Zeuner valve diagram, by means of which the valve displacement can be found for any position of the main pin, is a simplification of longer processes to obtain the same result, and its construction can best be studied by showing how this is done. Assuming an engine whose valve has no lap, as in Fig. 1, it is evident that $A'E$ and $A''E'$ represent the distance the center of the valve has moved from its mid position when the crank pin is at C' and C'' respectively. With the pin at C, the valve will be on the center of its seat. While the valve displacement for any position of the pin could be found by drawing the main crank and the crank representing the eccentric at right angles to each other, and then drawing a perpendicular to the vertical line AB, or AB produced, yet a simpler method of obtaining the same result is shown in Fig. 2. The valve displacements for the positions C' and C'' of the pin will be $A'E$ and $A''E'$. From A draw AF and AF' perpendicular to $C'B$ and $C''B$. Considering the two triangles AFB and BEA', the angle FAB is equal to the angle ABA', as AF is parallel to $A'B$. Also the angle AFB is equal to the angle BEA', as both are right angles. The side AB is equal to the side $A'B$, both being radii of the same circle. The two triangles are therefore equal and the side FB is equal to the side $A'E$. But $A'E$ represents the valve displacement when the crank pin is at C'; therefore FB also represents the valve displacement when the crank pin is at C'. It is then evident that the valve displacement for any position of the pin between C and D can be found by dropping a perpendicular from A to the line representing the main crank, while for the return stroke of the piston the corresponding valve displacements can be found by drawing the perpendiculars from the point A'.

The diagram has then been simplified to the extent of eliminating the line representing the valve crank, and the perpendicular from the extremity of this line to the vertical line AB; in other words, the valve displacement can now be found by dropping a perpendicular to the main-crank position and noting the intercept between the center and the point at which the perpendicular falls. However, the diagram can be still further simplified, and it will be shown next how the perpendicular to the main-crank position can also be eliminated.

Fig. 3 represents the main pin in three positions, C, C' and C'', and the corresponding valve displacements, FB, $F'B$ and $F''B$ have been measured off on the main crank by the perpendiculars AF, AF' and AF''. The three right-angled triangles, AFB, $AF'B$ and $AF''B$ are all described upon the same base AB. It can be proved by geometry that when a series of right-angled triangles are constructed upon a common base, their vertices all lie upon the circumference of a circle, the diameter of which is formed by the base line of the triangle. If a circle be described with such a diameter, the part of the line representing the main crank, which is intercepted between the center of the axle and the circumference of the circle, will then be the valve displacement for that position of the main pin. This circle, known as the valve circle, then renders unnecessary the drawing of a perpendicular to ascertain the valve displacement. The lower valve circle described upon the position of the eccentric radius $A'B$ with the pin at G gives the valve displacement for the return stroke of the piston. This completes the construction of the Zeuner valve diagram, considering an engine having a valve without lap.

Fig. 4 shows the diagram applied to a valve with lap, but with no lead, HON being the angle of advance of the eccentric. When this diagram is applied to a valve having lap, the angle of advance must be laid off negatively if a clockwise rotation of the main crank is to be considered, and the valve circles described, using as diameters the valve crank MO or MO produced to M'. If a negative angular advance is not assumed, that is, if NO or NO produced to N' is taken as the diameter of the valve circle, a negative rotation of the crank will have to be assumed. In this case, in order to find out how far the valve has moved from mid-position when the main crank has moved through a certain angle from one center, an imaginary crank must be assumed rotating through the same angle in the opposite direction from the other center. In order to avoid this a negative angular advance is assumed, although the diagram is sometimes found with the circles described on the positions the valve crank would assume in actual practice with the engine on either center, a negative rotation of the crank then being necessary. A negative rotation of the main crank assumes that the eccentric is fixed independent of the crank shaft, the whole engine revolving around the center of the axle, the direction of motion being such as already stated. Having described the valve circles, using MO and OM' as diameters, next, from the center O describe a circle with a radius equal to the lap. With the pin at A, the valve displacement is equal to OR, but as OR is equal to the lap, the valve displacement will be equal to the lap, or the valve will be at admission. With the main pin at B, the valve displacement is equal to

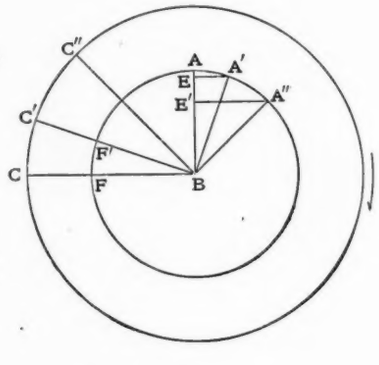


FIG. 1

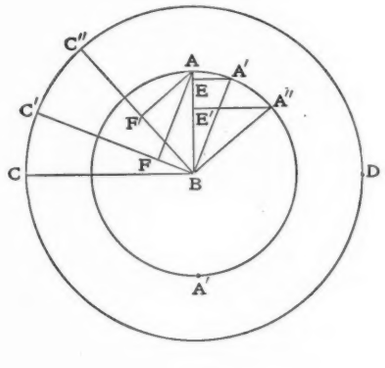


FIG. 2

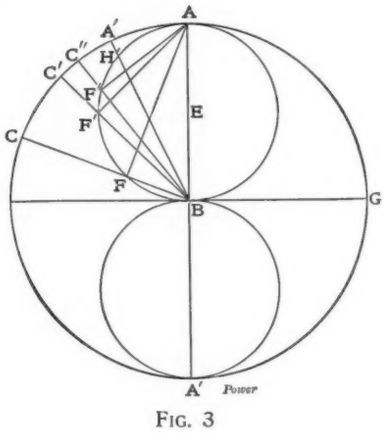


FIG. 3

$M O$, and the port opening equal to $M M''$, this position of the pin giving the greatest port opening. At C the displacement of the valve is again equal to the steam lap $O C'$, and the valve is at cutoff. At D the displacement is zero, no part of the main crank being found in either valve circle, the pin now being in mid-position and release about to occur at the left port and compression at the right port. With the pin at A the valve displacement is equal to the lap and the right-hand steam port will be on the point of taking steam. The left port will be open to the exhaust, an amount equal to the steam lap at this time. The lower valve circle shows the events for the return stroke of the piston. At M' the right-hand steam port is wide open, cutoff occurring with the pin at E, and release and compression with the pin at F.

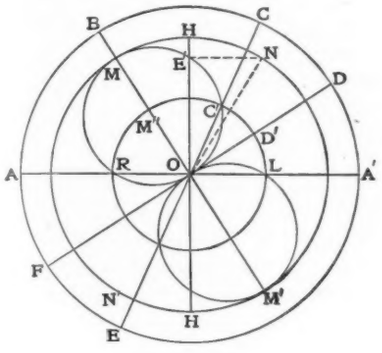


FIG. 4

Fig. 5 shows the diagram applied to a valve having lead. With the pin at A'' the valve displacement is equal to the lap $O C$ and the valve is on the point of opening the port. With the main pin at A, the valve displacement is equal to $L O$, and subtracting the lap $R O$ leaves a port opening $L R$ which is the extent of the lead. Cutoff occurs at E; if no lead existed this event would occur at F. Release and compression take place at G, and if no lead existed these would occur with the pin at H. With the pin at A' the port opening would be equal to the amount of lead $K I$. Considering the return stroke of the piston, the greatest port opening would occur with the pin at M'.

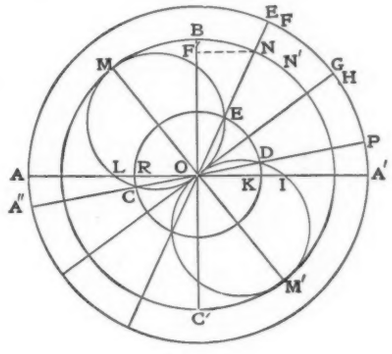


FIG. 5

Fig. 6 shows the diagram applied to a valve which has lead and exhaust lap, the inner circle being described with a radius equal to the exhaust lap. With the pin at F, compression is about to occur at the right-hand steam port. The valve will be in mid-position when the main pin is at G and release will occur at the left-hand steam port when the main pin is at H. With the pin at F and H the valve displacement is equal to $O F'$ and $O H'$; that is, it is equal to the exhaust lap. Considering the inner circle as being described with a radius equal to the negative exhaust lap with the main pin at F, the valve displacement is equal to the negative exhaust lap and release will be about to occur at the left steam port, and compression at the right port with the main pin at H. Cutoff occurs at the left port with the pin at E. The valve events for the return stroke are shown in the lower part of the diagram.

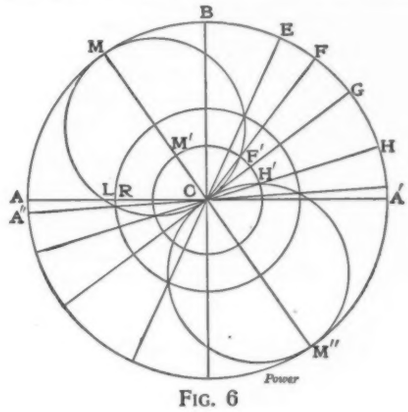


FIG. 6

Leakage through a Piston Valve

By George Mitchell

A significant fact, although one often lost sight of, is the enormous proportions assumed by the leakage past the piston valve of a steam engine; it reaching, in small engines, as high as 22 per cent. of the total steam consumption. When one stops to consider that this represents energy lost, its importance will at once be comprehended. The method herein described was devised by the author to measure this leakage under actual running conditions.

Obviously, valve leakage occurs because the valve does not fit perfectly into the cage in which it runs; that is to say, the difference in the diameters of the valve and cage is sufficiently great to allow a sensible amount of steam to escape between them. Though it might be possible to construct a valve with a fit so perfect that it would run with a small amount of friction and yet allow a negligible quantity of steam to escape through it, such is practically never the case; because if a valve of this type were made as above stated, it would probably be in such a condition only when the pressure of the steam was such that the expansions of the valve and cage were just of the right amount to produce the desired fit. Therefore, it is reasonable to suppose that some leakage would occur through any valve of the piston type, and it was the object of this experiment to determine as nearly as possible the amount of this leakage.

The subject of valve leakage is very important because through the existence of any leak between the steam chest and exhaust or between the cylinder and exhaust, or through the escape of steam in any way through the valve without doing the work which it is capable of doing, a certain amount of energy is lost, and the efficiency of the engine is reduced in direct proportion to the amount of this loss.

Many schemes have been devised for measuring the amount of leakage, but in general they are crude and for many reasons the results cannot be regarded as accurate. It is not necessary to enumerate the defects of these various methods; it will suffice to say that the most important defect common to all of them is that the leakage is not measured under normal running conditions, and erroneous assumptions are made regarding the leakage being the same when the engine is stationary as when running at normal load and normal speed. In deciding on a method for determining the leakage, the rule was strictly adhered to, that the leakage should be measured under running conditions that were as nearly normal and with as few assumptions as possible.

The tests were made at the mechanical laboratory of the University of Pennsylvania on a 6x6-inch simple engine equipped with a centrally balanced centrifugal governor and with a piston valve without rings, operating in removable bushings.

It was decided after due deliberation that it would be impossible to make the tests by using the standard valve supplied with the engine, because its length

was such as to preclude all possibility of separating the leakage from the steam in the cylinder, and on account of the exhaust passage through its interior, it would not be possible to separate the leakage from the exhaust. Further, if the standard valve had been used the leakage could have been determined only through one linear distance, that being the length of the valve face.

The method to be used for determining the leakage was finally decided upon as follows: That a special valve should be

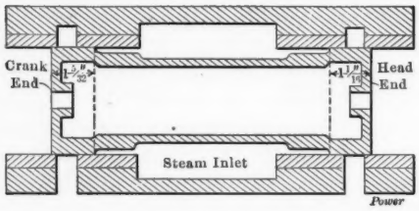


FIG. 1. STANDARD VALVE IN MID-POSITION

made by the makers of the standard valve so that as far as its fit was concerned, it should be similar to the original valve. The head end of the valve was to be the same as the standard head end, but the

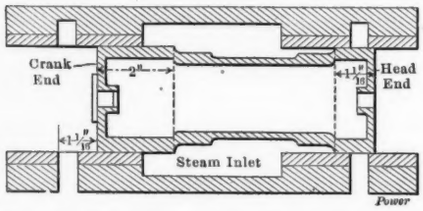


FIG. 2. SPECIAL VALVE IN MID-POSITION

crank end was to be made much longer so as to permit of being cut down to various lengths, through which the leakage could be measured. The total length of the valve was to be made much shorter than the standard length, this being done to permit the crank end to run only on the bushing on the inner side of the steam ports. It is now evident that if the engine were operated single acting by means of the head end, and a pipe were connected to the crank end of the cylinder, that when the engine was in action, all the steam coming through this pipe would be, if the exhaust passage of the valve were closed, the result of leakage through the valve and through the piston; and if the piston leakage were subsequently determined and subtracted from the total leakage, the result would be the valve leakage.

Fig. 1 shows a cross-section of the original valve in its mid-position, while Fig. 2 shows a cross-section of the special valve and bushing in its mid-position. It will be noticed that the only difference between the standard valve and the special valve is that the length of the crank end of the special valve is 2 inches while that of the standard valve is $1\frac{5}{32}$ inches. The total length of the special valve is $7\frac{3}{16}$ inches while that of the standard valve is $8\frac{13}{32}$ inches; also the exhaust passage in the special valve has been closed. Except for the above noted changes, the special valve is exactly similar to the standard valve. When the special valve is in mid-position, the distance it would have to move to close the crank-end steam ports is $1\frac{1}{16}$ inches, and as the maximum valve travel is 2 inches, it is evident that the crank-end ports will never be closed.

The general arrangement of the apparatus and the connections are shown by the photographs, Figs. 3 and 4. Pipe *A* is connected at one end to the relief valve *B*, on the crank end of the cylinder *C*. At the other end it is connected to the condenser *G*. The tank *D* is supported by the platform scales *M* and is placed immediately beneath the condenser-discharge pipe *E*. The scales *N* and prony brake *F* are for determining the brake horsepower of the engine on which the test was made.

The method of procedure for determining the valve leakage was as follows: It was first necessary to design the special valve referred to above, and for this purpose the standard valve was removed and measurements were taken of the valve and bushing. The standard valve was now replaced and the length of the valve rod was adjusted until the best possible indicator cards were obtained with the engine running at 15 horsepower, which was its normal rating. Next, the valve travels at various loads from 2.5 to 15 horsepower were determined by measuring directly the travel of the valve rod when the engine was running at the above loads, and a curve was plotted from these measurements. From this data the special valve was designed as shown in Fig. 2.

The steam consumption of the engine when running at various loads from 5 horsepower to 15 horsepower was next determined, the engine exhausting into the condenser and the condensed steam being collected in tank *D* and weighed. A curve of steam consumption at the various horsepowers was then plotted.

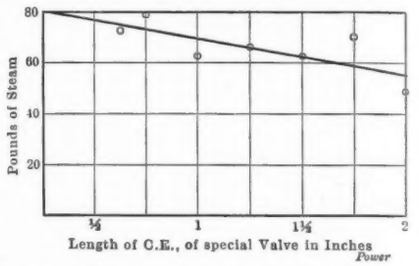


FIG. 5. LEAKAGE WITH VARIOUS LENGTHS OF VALVE

The test for leakage through the crank end of the special valve was then begun. The standard valve was replaced by the special valve and the valve rod adjusted so that the head end of the special valve was in exactly the same position as the head end of the standard valve when in its best position, as previously determined.

The throttle valve was now opened and the engine run single acting by using

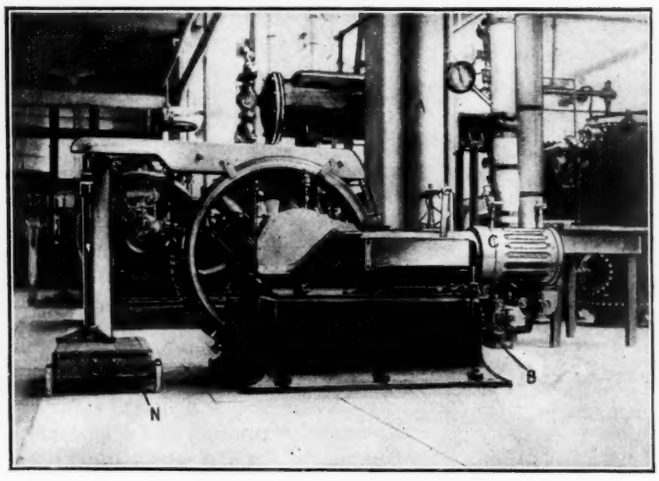


FIG. 3. ENGINE RIGGED FOR TESTING

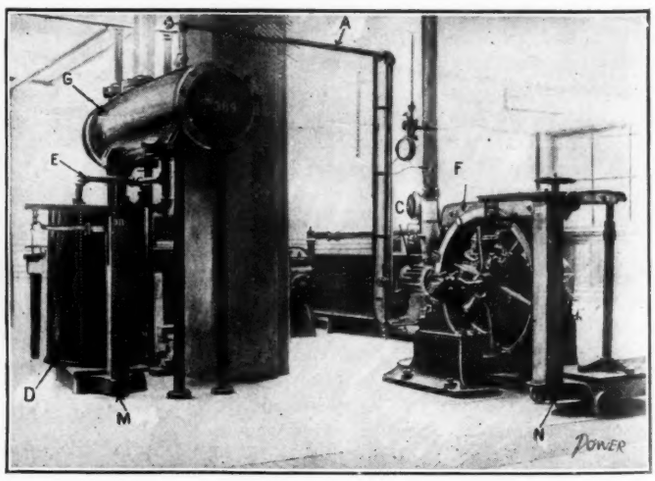


FIG. 4. REAR VIEW, SHOWING MEASURING APPARATUS

the head end. The leakage traveled through the crank end of the valve, entering the crank end of the steam chest, thence through the crank-end steam ports into the crank end of the cylinder, and

finally through pipe *A* into the condenser where the steam was condensed and weighed. After the engine had been running long enough for the leakage to become constant, a one-hour run was begun, observations being taken at the beginning and end of the run, and at intervals of ten minutes as follows: Steam pressure, valve travel, revolutions per minute, reading the scales *M* and also an indicator card for the head end of the cylinder. Six other runs were made in a manner exactly similar to the above, these runs being made with the length of the crank end of the valve 1¾, 1½,

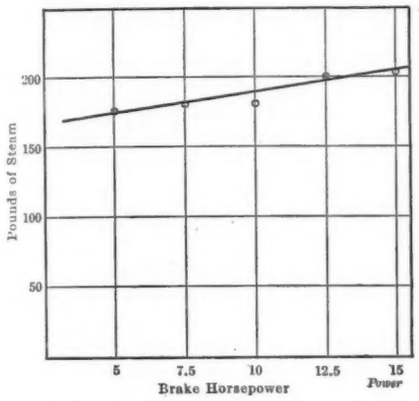


FIG. 6. ACTUAL LEAKAGE AT VARIOUS HORSEPOWERS

1¼, 1, ¾ and ⅝ inch respectively. The length of the crank end was shortened between each run by removing the valve from the steam chest and cutting off the inner edge of the crank end of the valve to the proper length, the total length of the valve remaining the same.

As the measured leakage included the leakage through the piston, it was necessary to measure this amount so that the net leakage through the special valve could be determined. The leakage through the piston was determined as follows: The special valve was removed and the steam ports at the crank end were plugged with wooden plugs which were accurately fitted and driven in. Holes were drilled in the crank end of the special valve, thus opening a continuous passage through the interior of the valve, and the valve replaced within the steam chest. The engine was blocked in such a position that the steam ports at the head end were uncovered so that the steam could have free access to the head end of the cylinder, and the crank end of the valve did not reach as far as the plugged steam ports. It is plain that the pressures on each side of the plugs were practically that of the atmosphere so that the tendency for leakage to occur was reduced to a minimum. All other connections were allowed to remain as before so that the leakage occurring was due to that through the piston alone. Half-hour runs were made with the piston in various parts of the stroke, observations being made at the beginning and end of the run and at intervals of 10 minutes as follows: Time, reading the scales *M* when balanced and the steam pressure.

A far more satisfactory method of measuring the leakage through the piston would have been to have measured this leakage when the piston was in motion and under running conditions as nearly normal as possible. Several attempts were made to accomplish this, but all ended in failure, due to the fact that the plugs which were used to close the steam ports could not be kept in place when the engine was running. However, as the piston leakage is small in comparison with the valve leakage, the error due to the method used is reduced considerably. In making the calculations the assumption was made that the leakage was proportional to the pressure.

The total leakage per hour through the various lengths of the crank end of the special valve, together with that of the piston, was reduced to equivalent leakage at 100 pounds pressure, and then the total leakage per hour at 100 pounds pressure was determined for the piston. The piston leakage being subtracted from the total leakage for each of the various lengths of the special valve through which leakage occurred, gave the net leakage through each of these various lengths, per hour at 100 pounds pressure. These results are shown by the curve, Fig 5.

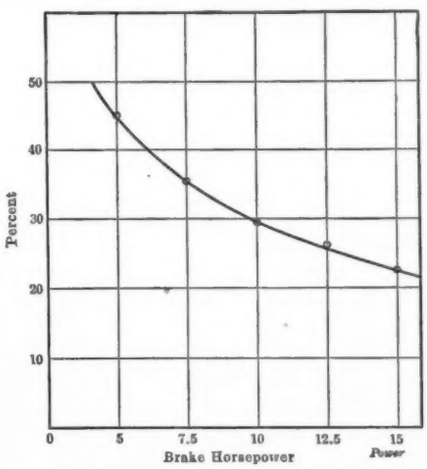


FIG. 7. LEAKAGE IN PERCENTAGE OF TOTAL STEAM USED AT VARIOUS HORSEPOWERS

Next, the equivalent distance constantly leaked through when the crank end of the special valve was at each of the various lengths was calculated, the results being shown by the curve in Fig. 6.

The actual leakage per hour at 100 pounds pressure through the standard valve was now calculated. With the engine running normally, leakage occurred as follows:

1. Between the steam chest and the exhaust passage, through the spaces between the steam ports.

2. Through the spaces equal in width to the steam ports between admission and cutoff.

3. Between the cylinder and the exhaust passage, through spaces equal in width to the steam ports between cutoff and release and between compression and admission.

In order to determine the amount of these leaks, it was necessary to know the equivalent distances constantly leaked through and the pressure at which the leakage took place. The valve travel at each of the various horsepowers was determined, and knowing the valve travel, the equivalent distance constantly leaked through in each case, for each of the various horsepowers, was calculated.

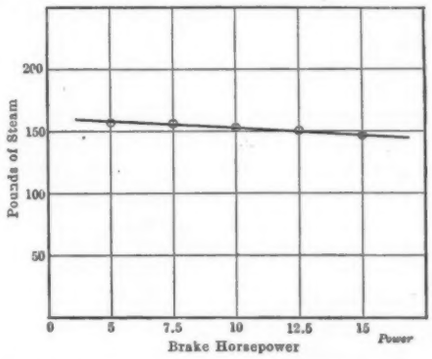


FIG. 8. LEAKAGE OF STEAM WHICH NEVER ENTERED CYLINDER

Leakage 1 occurred at a pressure equal to that of the steam chest as shown by the steam gage. Leakage 2 was due to this same pressure. Leakage 3, between cutoff and release, occurred at a pressure due to the average mean effective pressure of the expansion curves of the indicator cards for that particular run, and between compression and admission, occurred at a pressure due to the average mean effective pressures of the compression curves of the indicator cards for that particular run. Each of the above leaks was determined per hour at 100 pounds pressure by use of an equivalent distance curve.

This same method was used for each of the various horsepowers from 5 to 15, and the results were plotted as shown by the curve, Fig. 6.

The ratio of the total leakage through the standard valve to the total steam consumption at the various horsepowers was next determined, the results being shown by the curve in Fig. 7.

As the part of the leakage which occurred between the cylinder and exhaust passage consisted of steam which had done some work, another curve was drawn to show the amount of steam which never reached the cylinder at all, all the energy of which was absolutely lost. This curve is shown in Fig. 8.

In conclusion, the results show that leakage through the valve assumes enormous proportions. The total leakage increases slightly as the horsepower increases, and that the leakage of the steam which never enters the cylinder decreases slightly as the horsepower in-

creases. The leakage in per cent. of the total steam used decreases as the horsepower increases. However, a leakage of 22 per cent., even when running most efficiently, is a tremendous loss of energy, and it is probable that the valve is the most imperfect part of the engine and that more energy is lost here than at any other place.

Since the leakage is so large, it is evident that every effort should be made to decrease it. However, there is every reason to believe that the valve tested was as perfect as it is possible to make this form of valve. The remedy does not lie in attempting to make a more perfect fit for this form of valve, but in designing some new form of valve through which the leakage shall be a negligible quantity or at least considerably less than 22 per cent.

Loss in Coal Due to Excess Air

By H. J. Westover

The proper amount of air for complete combustion is of utmost importance. The most practical way of determining it is to first examine a sample of the flue gases for the percentage of CO_2, and from these results the required amount of air may be figured. The article is written primarily to acquaint the fireman with the methods used in making these determinations.

The easiest and most reliable method of determining the quantity of air passing through the furnace is by obtaining an analysis of the products of combustion, preferably finding the percentage of carbon dioxide. The following table has been computed to show the loss in percentage of heat against the percentage of carbon dioxide, also the amount of money annually lost where the yearly coal bill is $1000:

LOSS DUE TO INCOMPLETE COMBUSTION.

Percentage of CO_2.	Loss, Per Cent.	Loss, Dollars.
14	no loss	.....
13	1½	15
12	2½	25
11	4½	45
10	6	60
9	8½	85
8	11	110
7	15	150
6	19½	195
5	26½	265
4	32	320
3	53½	535

If the percentage of CO_2 is known, one can see at a glance from this table, how much coal has been lost. These figures are not based on fictitious values but are figured on the actual amount of heat escaping to the chimney. There is no hidden mystery in the matter, whatever; a thermometer will show the temperature of these gases and the CO_2 determination will give the exact quantity of heat carried away.

These losses have not been figured from the best results obtainable, but from conditions that a good fireman can attain. If the stack temperature exceeds 525 degrees Fahrenheit, the loss will be greater than those given in the table, varying directly as this temperature increases.

The tests made by weighing both water and coal compare favorably with the above table. The figures shown in the table are a trifle higher for from 3 to 10 per cent. of CO_2, but above 10 per cent. there is practically no difference.

The method of figuring these percentages is given so that an intelligent fireman can get at the theory of his work and make the calculations for himself.

The work of the fireman has not been accorded the importance due it. The fireman is partly to blame for this. He should consider himself in the light of a manufacturing chemist, his business being to chemically combine carbon and hydrogen with oxygen, and the following remarks have been written for his benefit. He will find the work far more interesting when he understands the theory of combustion.

Coal is composed of carbon, hydrogen and several other elements, mostly unimportant. The only part of the coal we need to consider in this discussion is the carbon and the hydrogen. The sulphur and other elements, even when combustible, are not of much value.

At the start it is desirable to have a clear understanding of what is meant by "combination." If some red lead is mixed with white sand and soda, the particles of the mixture can again be separated, and after doing so the red lead, sand and soda would be the same as before. If, on the other hand, this mixture is placed on the end of a slice bar and put into the fire, the mixture will melt and upon removing it there will be a rough-looking piece of glass adhering to the slice bar, the red lead, sand and soda having disappeared. However, they still exist, but in a combined state, and it is no longer possible to take out a particle of sand or red lead. The new substance differs from any one of the original ingredients. This is what is termed a chemical combination and it differs in this respect from a mixture.

The carbon and hydrogen in coal combine with the oxygen of the air. This is a chemical combination and the result is a new substance, namely, carbon-dioxide gas and water. This new substance, CO_2, is totally unlike the coal, but at the same time every grain of carbon is contained in it.

It is a well known law in chemistry that the chemical elements combine with each other in exact proportions; for example, 1 pound of hydrogen will combine with 8 pounds of oxygen, forming 9 pounds of water. The same holds true with carbon; 1 pound combines with 2⅔ pounds of oxygen—no more, no less—to form carbon dioxide.

It is due to this indisputable fact, namely, that carbon, hydrogen and oxygen, combine in exact proportions, that the amount of air can be determined when we know the percentage of CO_2.

As already stated the sulphur and other minor ingredients are not important enough to be considered, and as no oxygen is required for the ashes no air is needed for the ash in the coal. We can also neglect the other combination wherein carbon unites with oxygen to form carbon monoxide, as there is at the present time very little of this gas formed in the ordinary furnace.

This is the gas formed when the damper is suddenly opened at a time when a very bright fire is burning. It is due to a shortage of air. However, as a rule, when looking through the holes in the fire door a light blue flame will be seen burning on the surface of the coal. This is the carbon monoxide meeting the leakage of air through the fire doors and burning to CO_2.

Analysis show that the soft coals in use throughout the United States consist of 94 parts of carbon to 6 parts hydrogen in every 100 parts of pure combustible, and if the coal has 10 per cent. ash it would require about 110 pounds of coal to furnish 94 pounds of carbon and 6 pounds of hydrogen.

The exact amount of air necessary to burn this 110 pounds of coal, consisting of 94 pounds of carbon and 6 pounds of hydrogen may be found. As previously stated, 1 pound of carbon requires 2⅔ pounds of oxygen to form CO_2 and 1 pound of hydrogen requires 8 pounds of oxygen to form water.

Carbon,	$94 \times 2\frac{2}{3} = 250\frac{2}{3}$	pounds oxygen
Hydrogen,	$6 \times 8 = 48$	pounds oxygen
Total.....	$298\frac{2}{3}$	pounds oxygen

That is, 298⅔ pounds of oxygen are

required to burn the 110 pounds of coal. The oxygen is obtained from the air where it exists in the proportion of 23 pounds of oxygen to every 100 pounds of air. We shall therefore require

$$\frac{298.66 \times 100}{23} = 1298$$

pounds of air.

The air consists of oxygen and nitrogen and to obtain the oxygen it is necessary also to take the nitrogen. This is of no value; in fact, it is a decided loss, but it is unavoidable. The nitrogen exists in the proportion of 77 pounds in every 100 pounds of air. Hence,

$$\frac{1298 \times 77}{100} = 1000$$

pounds, approximately, of nitrogen in the air required for combustion.

The gases passing up the chimney therefore consist of nitrogen, carbon dioxide and some steam from the water formed by burning the hydrogen. The weights of these gases are as follows:

Carbon	94 pounds
Oxygen	250⅔ pounds
Carbon dioxide	344⅔ pounds
Hydrogen	6 pounds
Oxygen	48 pounds
Water	54 pounds

This makes a total of,

Carbon dioxide	344⅔ pounds
Water	54 pounds
Nitrogen	1000 pounds
	1398⅔ pounds = weight of gases going up the stack

So far, these quantities have been given in weight. For the convenience of measuring, they may be converted into cubic feet at atmospheric pressure and 72 degrees Fahrenheit. Further, in bringing these products of combustion to the machine for analyzing, we do not bring the steam or vapor as this is collected before the gases enter the measuring chamber. One pound of nitrogen occupies 13.8 cubic feet, and one pound of carbon dioxide occupies 8.8 cubic feet. These quantities will measure as follows:

		Cu.Ft.
Nitrogen,	1000 × 13.84 =	13,840
Carbon dioxide,	344⅔ × 8.8 =	3,028
Total		16,868

If exposed to a solution of caustic potash, the 3028 cubic feet of carbon dioxide would be absorbed, leaving the 13,840 cubic feet of nitrogen. The proportion of the total space to the space occupied by the CO_2 would be as 16,868 is to 3028, which is the same as 100 is to 18. Hence, the percentage of CO_2 gas is 18.

It will be noticed that the amount of nitrogen and oxygen required was 1000 and 298⅔ pounds respectively, making 1298⅔ pounds of air, and as 1 pound of air at 72 degrees Fahrenheit occupies 13.5 cubic feet, the 1298⅔ pounds of air would occupy 17,532 cubic feet. The ratio of the total volume of carbon dioxide to the volume of original air—17.3 per cent.—is not exactly the same as the ratio of carbon dioxide to the flue gas—18 per cent. This is due to part of the oxygen being taken for the hydrogen to form water. The larger the percentage of hydrogen in the fuel the larger the amount of air required.

In burning oil fuel more air is required for a given weight than for bituminous coal. On the other hand, less air is needed for anthracite coal than bituminous, because oil contains more hydrogen and anthracite less than bituminous coal.

The carbon combining with the oxygen does not increase the volume but it does increase the weight. It will be seen that if this fuel could be burned with just the quantity of air necessary for complete combustion the CO_2 would be 18 per cent.; but furnaces are not constructed so that every particle of fuel will come into contact with every particle of oxygen; consequently a margin is required and the greater the attention given to the handling of the fire the smaller will be the margin needed.

It has been found from practice that 14 per cent. of carbon dioxide is about as good as can be obtained, and it would be difficult to maintain this constantly with a changing load; however, this should be the mark aimed at.

To find the amount of surplus air for 14 per cent. of carbon dioxide proceed as follows: The products of combustion are proportional to the CO_2 gas; with 18 per cent. CO_2 the products of combustion measured 16,868 cubic feet; at 14 per cent. CO_2 the products would be 21,600; as 14 is to 18 so will 16,868 be to 21,600 and the value of these items will be

	Cu.Ft.
Nitrogen	13,840
Carbon dioxide	3,028
Surplus air	4,732
Total	21,600

Seeing that the products of combustion vary inversely as the percentage of CO_2 and it is desired to find what these will be for 6 per cent. of CO_2 we divide 18 by 6 and multiply by the products of combustion for 18 per cent. of CO_2, viz.,

$$\frac{18 \times 16,868}{6} = 50,619$$

Proceeding as before, we have

	Cu.Ft.
Nitrogen	13,840
Carbon dioxide	3,028
Excess air	33,751
Total	50,619

This represents an excess of 29,019 cubic feet over that required for 14 per cent. of carbon dioxide.

Now proceed to determine the amount of coal which would be required to heat this amount of excess air to the temperature at which it enters the stack and compare it with the original, this proportion being the percentage of loss.

Converting 29,019 cubic feet into pounds at 72 degrees Fahrenheit we have $\frac{29,019}{13.5} = 2150$ pounds of air entering the furnace. The same weight of air leaves the stack at 525 degrees Fahrenheit. To raise 1 pound of the gases 1 degree Fahrenheit requires 0.236 B.t.u.; hence, it will take

$$(525 - 72) \times 0.236 = 107 \text{ B.t.u.}$$

to raise one pound from 72 to 525 degrees; consequently, to raise 2150 pounds of air to this temperature it will take

$$2150 \times 107 = 230,050 \text{ B.t.u.}$$

With a fairly good grade of bituminous coal having a heat content of about 14,500 B.t.u., and with 14 per cent. of carbon dioxide, 11 pounds of water can be evaporated from and at 212 degrees Fahrenheit per pound of coal. The actual B.t.u. required to evaporate 11 pounds of water under these conditions is 10,615.

Referring to the 230,050 B.t.u. required to raise 2150 pounds of air from 72 to 525 degrees, it will be found to take as many pounds of coal to furnish this heat as 10,615 is contained in 230,050.

$$\frac{230,050}{10,615} = 21.5$$

pounds of coal. This represents a loss of 19.5 per cent. of the original 110 pounds of coal.

A sample of gas showing 12 per cent. of carbon dioxide can often be obtained at some favored spot in the furnace when another sample at the same time taken at the breeching will show only 6 per cent. There is quite an art in obtaining a good average. It is quite possible to get a sample which is not a sample of the average gas and consequently the correct amount of air cannot be determined from such a sample. The CO_2 gas in most boilers is found richest in the center and poorer at the sides, front and end. This is due to the more rapid combustion at the center. As a rule the best average sample of gas for determining the loss due to excess of air is to be had at the breeching. The products usually are well mixed before entering the reduced orifice leading into the breeching and the stratified condition of the products often observed in the setting is well broken up at this point. The products at this point are carrying away heat at a temperature which can be measured without question and the quantity can be definitely determined.

For use during cold weather, when the trains of the Pennsylvania railway entering the New York station through the electrified-tunnel zone are disconnected from their steam locomotives and taken across the Jersey meadows and through the tunnels by electric locomotives, steam generated in electric boilers will be used to maintain the temperature in the cars and to keep the train connections from freezing. These boilers, which will utilize the 600-volt direct current from the third rail, are to be capable of generating 1000 pounds of steam at 80 pounds pressure.

A Homemade Reducing Motion

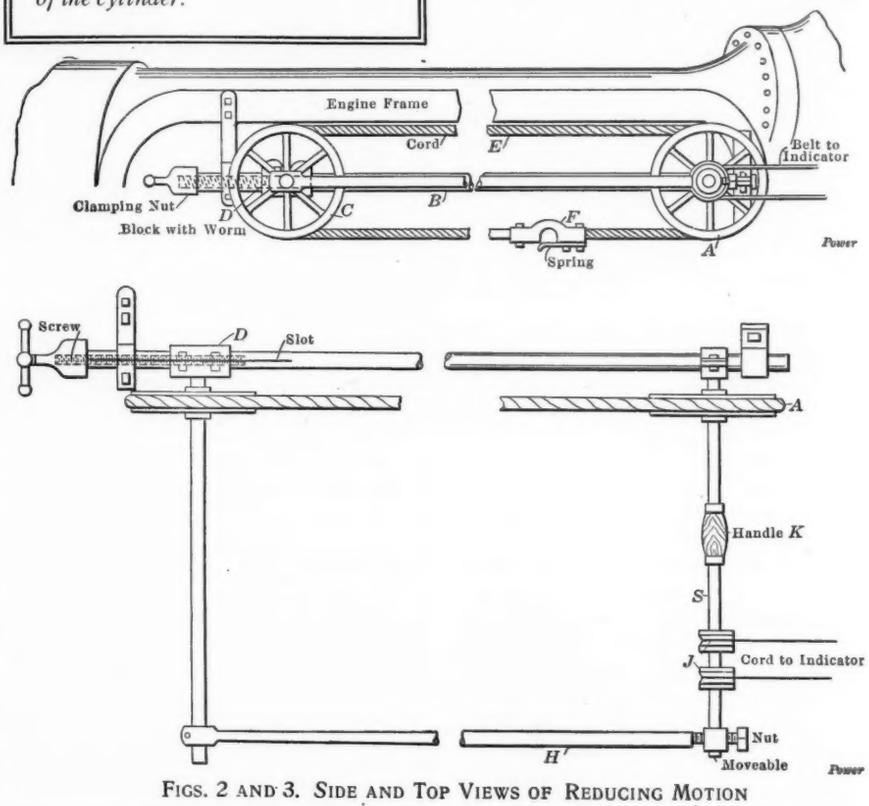
By Warren O. Rogers

Although the reducing motion is a homemade device, it is accurate and convenient to operate. When the device is applied to an engine it is a simple matter to take simultaneous diagrams from each end of the cylinder.

While visiting a cotton-mill power plant at Knoxville, Tenn., recently, the writer noticed a homemade reducing motion that was out of the ordinary, and yet of such a design that the reduction and formation of the diagram were practically perfect. The illustrations, Figs. 1 and 2, show the device attached to the low-pressure cylinder of a cross-compound Corliss engine.

The reducing motion consists of two brackets, one being secured to each end of the engine girder frame by means of screw bolts. A brass rod extends to and through these brackets, and is held in position by split-bearing clamps. A clamp is secured on each end of this brass rod, each clamp having a projection on the bottom in which a stud is fitted. On this stud a grooved pulley is loosely fitted, as shown in Figs. 1 and 2. The stud of pulley *A*, Fig. 2, remains fixed relative to the shaft *B*, but the stud of pulley *C* is adjustable. Inside of the rod *B* is a screw fitted with a crank handle, such as is used on the tailstock of an ordinary engine lathe. This screw engages with a female piece which is bolted to the clamp or bearing piece *D*. A thin extension of the female threaded nut is bolted to the clamp *D* and slides in a slot in the rod *B*. The purpose of this arrangement is to allow tightening the cord *E*, to prevent slipping. The bottom of the pulleys *A* and *C* come on a line with the center of the crosshead, in order that the pin projecting from the crosshead may engage in the hook link *F*. This connecting piece is made with a spring which fits to the under side; one end is fastened by means of screws, but the other end is free to give. The spring is turned down at the end so that the pin in the crosshead in striking the link forces the spring away from the engaging piece, and the crosshead pin, slipping into the pocket of the engaging piece, is held fast by the spring.

Fig. 3 shows a plan view of the device. The cord wheel *A* is fitted to a hollow shaft which runs on an inner shaft. This is for the purpose of disengaging the crosshead pin from the catch device while the engine is running. The outer shaft



FIGS. 2 AND 3. SIDE AND TOP VIEWS OF REDUCING MOTION

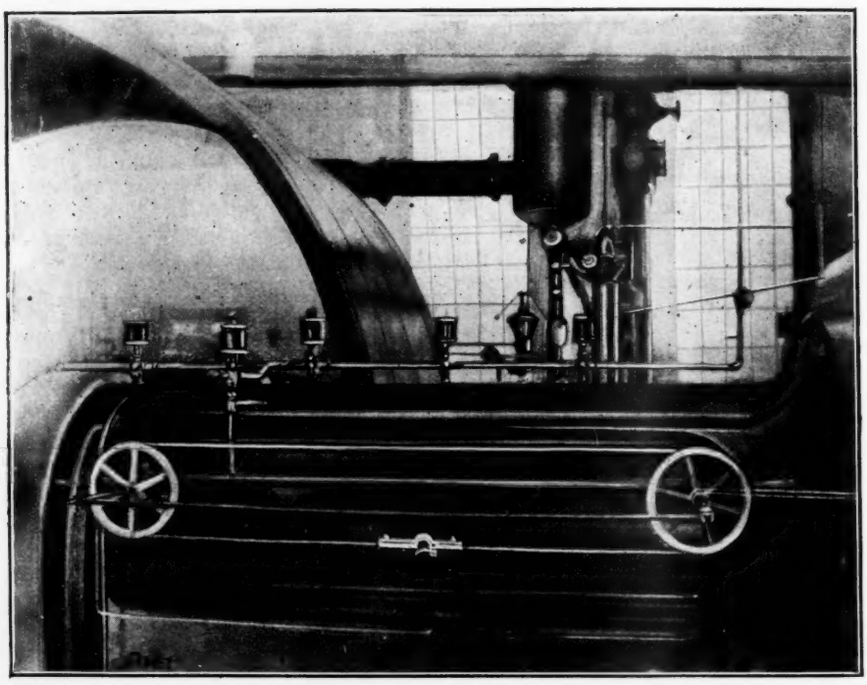


FIG. 1. REDUCING MOTION ATTACHED TO ENGINE FRAME

is fitted with a handle, and when it is desired to disconnect the reducing motion, the handle is pulled away from the crosshead. This draws the wheel *A* also, and the crosshead pin slips out of the engaging piece when it has reached a distance from the crosshead greater than the length of the crosshead pin.

The rod *H* is for the purpose of supporting the shaft *S*, on which two pulleys *J* are secured. These pulleys are of such size as to produce a diagram of the proper length. Two are used so that a diagram from each end of the cylinder can be taken at the same time. The only operation necessary after placing the paper on the indicator drum is that of moving the handle *K* in toward the engine, and then move the catch device to any position on the under side of the pulley, so that the crosshead pin can engage with the catch piece.

The cord running over the pulley is about ⅜ inch in diameter, which size prevents stretching or slipping. The device is interchangeable and can be used on any engine by changing the pulleys.

High Speed Compound Engine Design

By J. D. Speedium

The third and concluding instalment to the problem in English high-speed engine design. The engine frame, bearings, oiling system and governor are here dealt with.

Crank Shaft and Flywheel

The crank shaft is illustrated in Fig. 28. This is made from a solid forging of Siemens Martin acid steel having a tensile strength of not less than from 56,000 to 64,000 pounds per square inch. It is of larger diameter than is necessary to transmit either the torsional or bending stresses to which it is subjected, but this is absolutely necessary to provide ample bearing surfaces. Under ordinary working conditions the pressure per square inch on the bearings—taking the area equal to the diameter multiplied by the length—does not exceed 200 pounds. Four main bearings are provided, the one

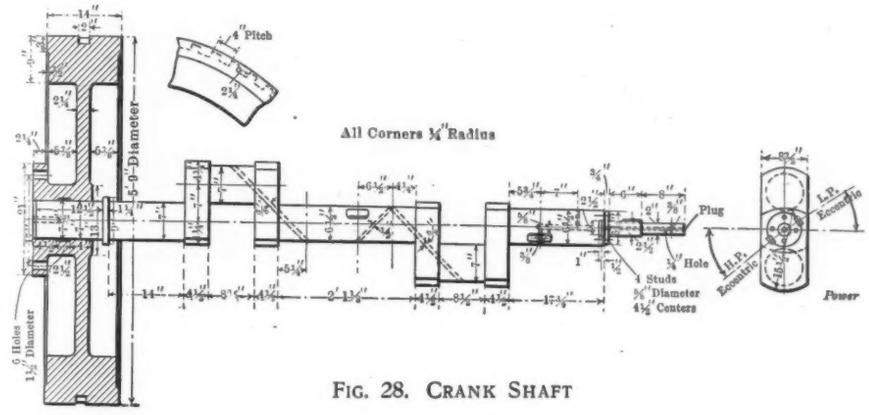


Fig. 28. Crank Shaft

near the flywheel being considerably longer than the others, to carry the weight of the flywheel and part of the rotor of the dynamo, if the engine is used for that purpose.

To lubricate the crank pins a hole is drilled at an angle from the nearest main bearing through the web to the pin. A small extended shaft is bolted onto the end of the crank shaft at one end to carry the governor, this shaft being provided with a spigot to fit into a suitable recess in the main shaft. The governor is lubricated by a hole drilled up through the end of the shaft to meet a hole drilled from the outside on the nearest main bearing.

Nearly all two-crank engines have the cranks placed at 180 degrees. This gives the best balance for running at high speeds, and at the same time reduces the load on the main bearings. In the case of engines running at very high speeds, balance weights are fitted to the cranks, these being arranged to balance the crank pin, with the webs, and in addition about 50 per cent. of the reciprocating parts.

Great accuracy is necessary in machining the crank shaft to insure a smooth-running engine; consequently, it is usual to specify that the crank pins and main bearings shall not be more than 0.002 inch out of round, and the crank pins not more than 0.002 inch out of parallel with the shaft, in a length of 12 inches. These limits are adhered to even for the larger shafts.

Owing to the high speed of rotation, the flywheel is usually of small diameter, being made in plate form, which no doubt is the strongest and most suitable design possible. A speed of 6000 feet per minute on the periphery of the wheel is generally adopted and rarely exceeded. For powers up to about 800 horsepower it is usual to force on the flywheels by hydraulic pressure, afterward drilling one or two round keyways half in the wheel and half in the shaft, see Fig. 28.

In the early high-speed engines, great trouble was experienced from flywheels working loose, as they were made only a fair fit on the shaft, and keyed in the ordinary way. Flywheels forced on the shaft, however, never give any trouble in this respect. For larger sizes of engine it is usual to provide a solid coupling on the end of the crank shaft, and bolt the flywheel plate between this coupling and the dynamo coupling, a small spigot being provided on the face of the engine coupling to center the flywheel.

As regards the weight of flywheels for ordinary stationary practice, a weight giving approximately 700 to 800 foot-pounds of stored energy per indicated horsepower is found sufficient, and for traction purposes, etc., a weight of 1500 to 2000 foot-pounds of stored energy should be used.

Oil Thrower

A small detail which has caused much trouble during the development of high-speed engines is the method of preventing oil from escaping through the frame through which the crank shaft projects to carry the flywheel. Again, owing to the temperature rise which occurs after an engine has been running some hours, it has been found necessary not only to

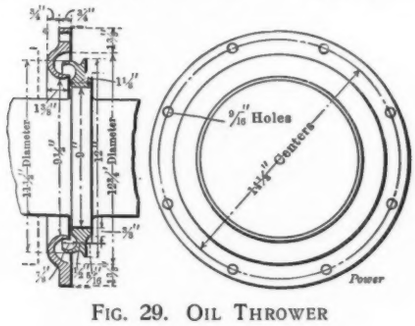


Fig. 29. Oil Thrower

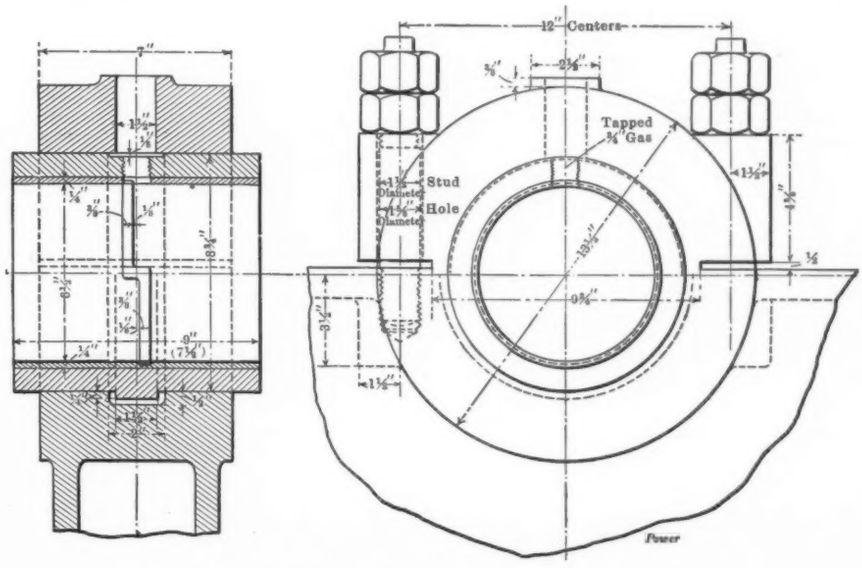


Fig. 30. Intermediate and Governor End Bearings

prevent the oil leaking out, but to prevent the oil vapor and spray from leaking out and coming in contact with the electrical machines.

When the bearings of an engine are entirely inclosed in the frame, with an oil thrower fitted beyond the bearings, it is difficult to prevent the vapor from escaping. In the present engine, this defect is overcome by fitting a flange on the main bearing cap of the flywheel; this makes an oil-tight joint on the end of the frame, and the only oil or vapor which can leak out has to pass through the bearing. This is easily dealt with by means of an oil thrower of the design shown in Fig. 29; the oil collected in the outer ring or scoop being drained back into the engine base through a hole seen in Fig. 31; and it is only through this hole that oil vapor can pass.

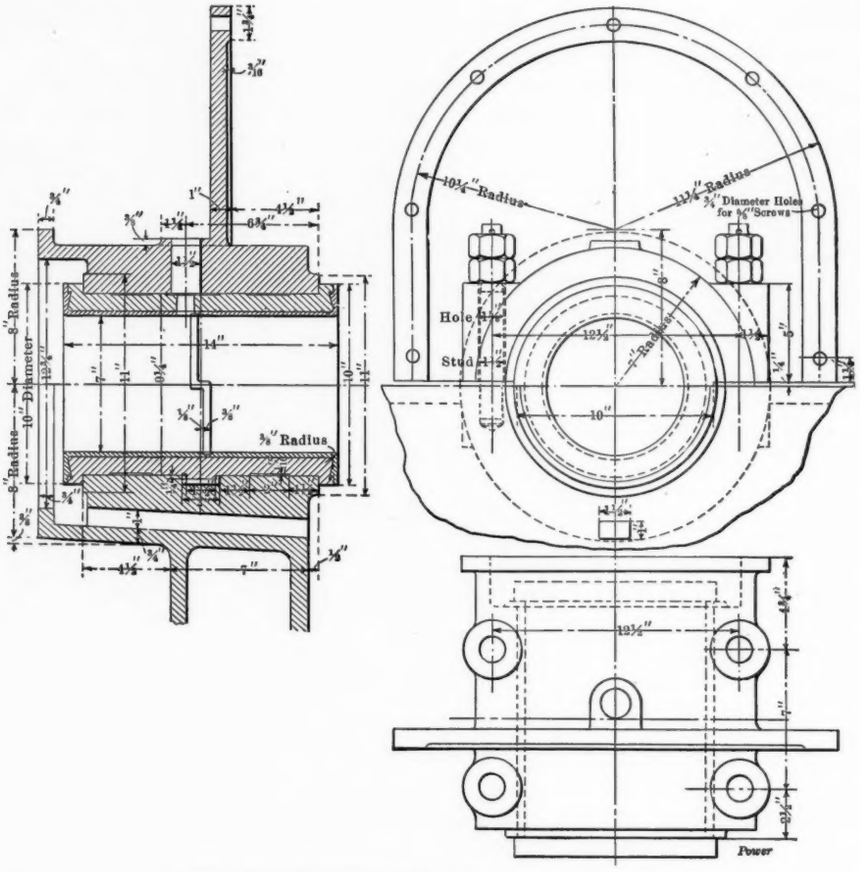


FIG. 31. FLYWHEEL END OF MAIN BEARINGS

MAIN BEARINGS

The main bearings for the crank shaft are shown in Figs. 30 and 31. The shells or bushes are usually made of cast iron, and are lined with antifriction metal. The caps are also of cast iron and are spigoted into the base as shown. This spigot fulfils two purposes: It centers the caps, and at the same time prevents the bushes from rotating. By making the bushes in this way, it is possible to remove the bottom halves without lifting the crank shaft, as they can be turned round the shaft and lifted out, when the cap and top-half bearing have been removed. The caps are secured by studs fitted with two nuts, one acting as a lock nut, and in addition a split pin is fitted.

The oil is fed into the top of the bearing, through a pipe which is screwed into the top half of the bush, and passes through a hole cut in the cap, the bearing being grooved to distribute the oil around the shaft.

The flywheel end bearing, Fig. 31, is used as a thrust bearing, and is accordingly provided with collars at each end, the antifriction metal being carried over the end faces which come in contact with the crank shaft. A central collar is provided on the bottom half of this bush to prevent it from rotating with the shaft. In the case of the other bearings this collar also prevents the bush from moving longitudinally.

ENGINE FRAME AND BASE

The engine base shown in Fig. 32 practically consists of a tank with sides of box-girder section. The two outer main bearings are carried by the ends of the casting, and the two inner bearings are carried by intermediate ribs, which span the center of the bed. Owing to the ample supply of lubrication required in high-speed engines, it is necessary to entirely inclose all the working parts; hence the frame and base are practically a sealed box when the engine is running.

The frame is shown in Fig. 33, and consists of a strong box, well ribbed to give stiffness and provided with doors to afford easy access to the working parts. The bottom is flanged where it sits on the base and is secured by closely pitched studs. The top of the frame is inclosed and is strongly ribbed to receive the distance-piece castings which carry the cylinders. The holes for the doors are made as large as advisable and have semicircular ends. Two doors are also fitted to the base, one at the back and one at the front, to give access to the oil pump and strainer.

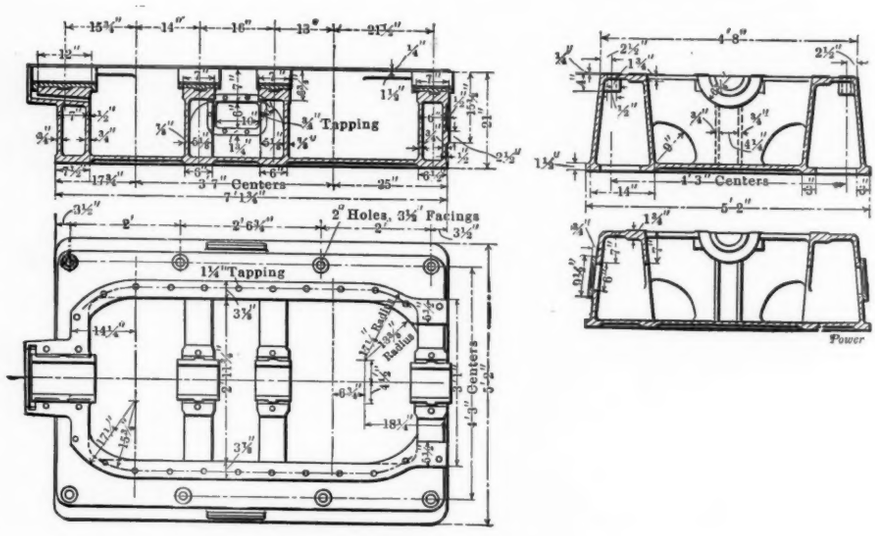


FIG. 32. ENGINE BASE

The foundation bolts, eight in number, are carried through the whole depth of the base and thus have a very firm hold on the engine. The right-hand side of the frame and base is worked to a circular form and is provided with a facing, to

which the governor casing is attached, the governor also being entirely inclosed.

Oil Pump and Strainer

The oil pump and strainer are detailed in Figs. 34 to 36. The pump is of the valveless type and is actuated from a lug cast on the low-pressure eccentric clip; see the assembled drawing, Fig. 46. From this it will be seen that the pin, which works the oil pump, makes an elliptical path and causes the ram, together with the oil-pump barrel, Fig 34, to oscillate through a considerable angle on the trunnion, Fig. 35. During the in-stroke of the ram the port in the bottom of the barrel is open to the suction port in the trunnion, and on the out-stroke, the oscillation of the barrel puts this port in connection with the delivery port in the trunnion; hence no valves are necessary. The pump ram is usually of gun metal and is a good working fit in the barrel, which is of cast iron. No packing is necessary, and as the ram works under most favorable conditions as regards lubrication, very little wear takes place. The trunnion, Fig. 35, which is of cast iron, is divided into two compartments, most clearly seen in section in Fig. 35a. It is made a templet fit in the bracket which carries it, and is prevented from turning round by means of two pinching screws at the top. The suction pipe is connected by a flange to one end of the trunnion and the delivery to the other.

There is no fixed rule for determining the capacity of the oil pumps, as the capacity has to be determined by experience; they are usually made larger than required, so as to give some margin for wear of the parts and leakage. Pumps are fitted of such a capacity as to maintain an oil pressure of at least 20 pounds per square inch after considerable wear has taken place.

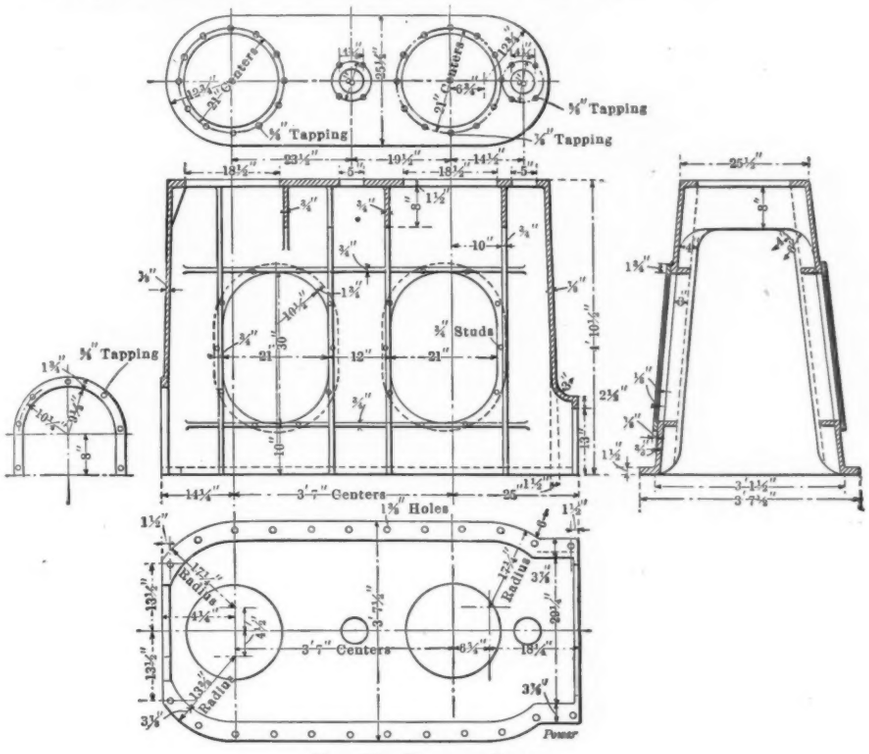


Fig. 33. Engine Frame

In Fig. 36 are illustrated the oil strainer and trough. This is a very important detail, as it is absolutely necessary to prevent any grit from getting into the suction pipe. A small amount of grit in a bearing on a slow-speed engine will only cause that bearing to heat up, but if grit gets into the suction pipe of a forced-lubrication engine it is immediately distributed over all the working parts.

The strainer consists of a light, perforated tube closed at one end and fitted with an open branch at the other. The open end is made to engage with the conical seat of a spring-loaded piston valve containing one set of ports. When the strainer is in position the ports in the small piston valve are open to the suction pipe, but as soon as the strainer is removed, the spring pushes out the piston valve and closes the ports, thus preventing the pump from sucking oil direct from the engine base, should it be found necessary to remove the strainer while the engine is running. The perforated tube of the strainer is wrapped with fine copper-wire gauze. The strainer can be removed easily, as it is held in place only by the valve. The trough is fitted as an additional precaution against grit getting into the suction pipe. Also, the trough prevents water from being drawn into the pump. A pure mineral oil is used for lubrication and the same oil is often used for many months without filtering or changing. Engines of this type regularly run for six months without a stop and without change of oil.

Governor

High-speed, inclosed, forced-lubrication engines are universally governed by a throttle valve. The governor is of a simple centrifugal type and is fixed on the end of the crank shaft. Through the sleeve and bell-crank lever inclosed in the governor casing it is connected directly to the throttle valve. This valve is shown in detail in Fig. 37 and consists of a double-seated balanced valve with steam entering at the top. Both valve and seat are made of cast iron, but the valve box

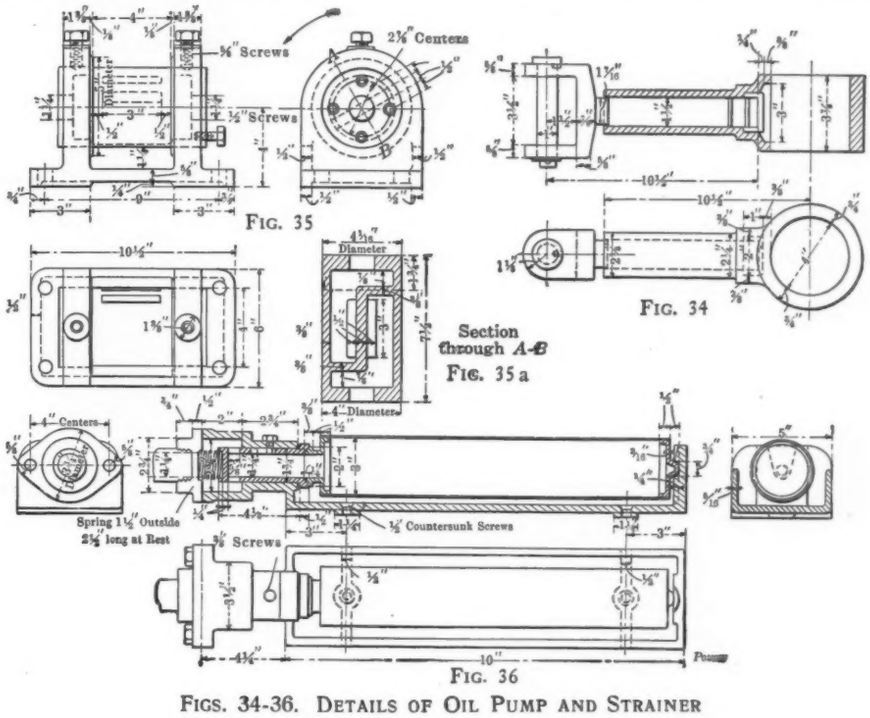


Fig. 35 Fig. 34 Fig. 35a Fig. 36

Figs. 34-36. Details of Oil Pump and Strainer

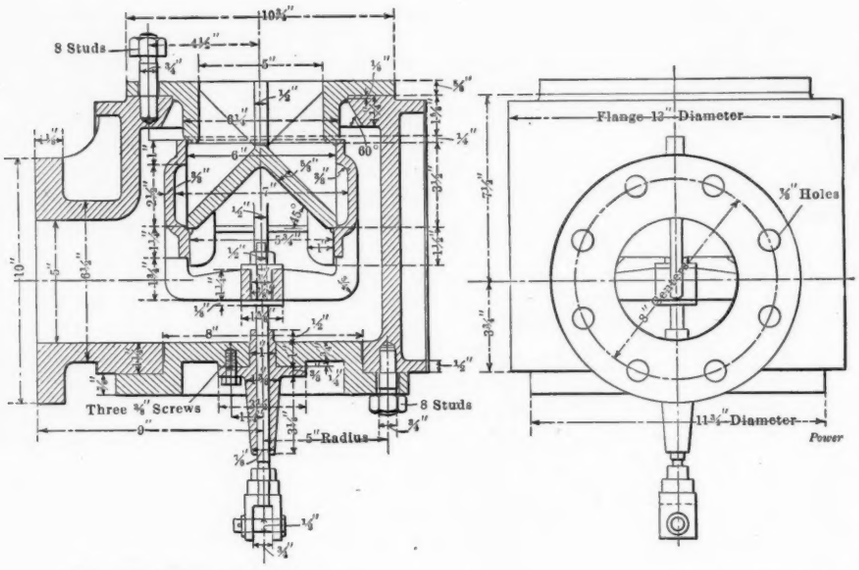


FIG. 37. THROTTLE VALVE

is usually made of cast steel for pressures exceeding 150 pounds per square inch. The seat is let in from the top side and is held in position by the same studs which secure the steam-pipe flange. As the seat is not constrained in any way, only being supported at one end, it is not liable to be distorted; consequently the valve remains tight under all conditions of pressure and temperature. The valve is a floating fit on the spindle and can thus freely center itself on its seat. No packing is fitted to the throttle-valve spindle, but a long, closely fitting bush takes its place. This arrangement is preferable to a gland and stuffing box, as it cannot be tampered with. It is usual to adjust the governor so that the valve is pressed hard onto its seat when the governor balls are in their out position. The spindle is made adjustable at the knuckle joint just below the bush through which it works.

The details of the governor are shown in Figs. 38 to 42, Fig. 38 showing the bracket which carries the weights. The fulcrum pins are case-hardened and are lubricated by oil under pressure, a hole being drilled through the center of the crank shaft and making connection with the nearest main bearing; see Fig. 28.

The governor weights and levers are shown in Fig. 39. These are usually made of cast steel. The weight portion is made hollow, a cap being fitted at either end. Lead washers can thus be added in the pockets until the correct speed is obtained. A steel pin, fitted with hardened-steel ferrules at each end for attachment to the springs, is forced through the center of each weight. The other ends of the levers are fitted with pegs on which

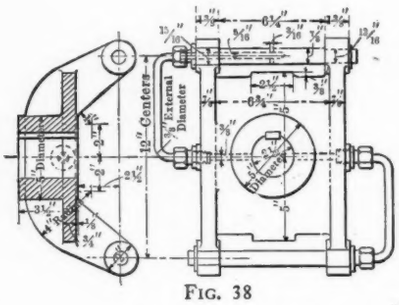


FIG. 38

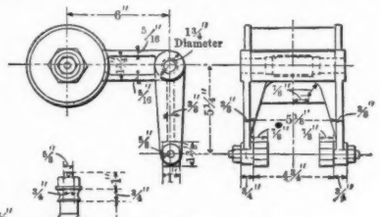


FIG. 39

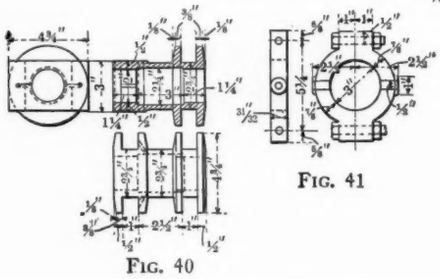


FIG. 41

FIG. 40

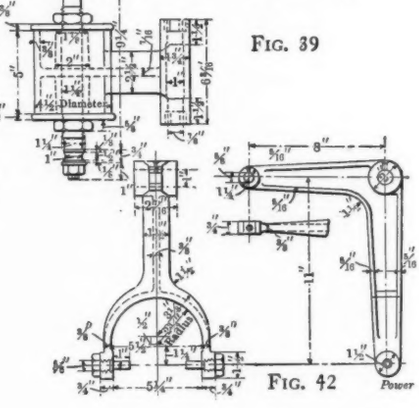


FIG. 42

FIGS. 38-42. GOVERNOR DETAILS

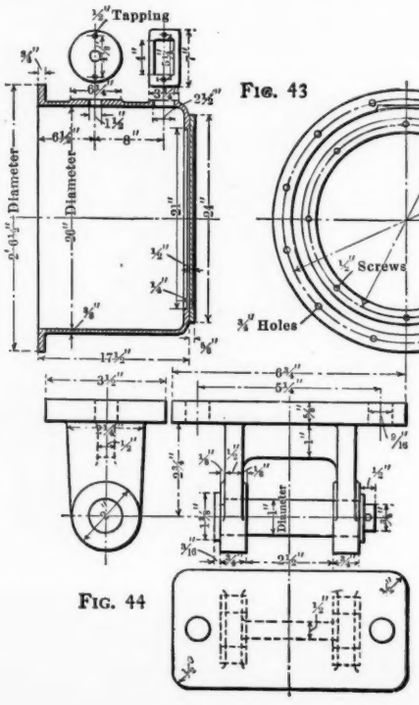


FIG. 43

FIG. 44

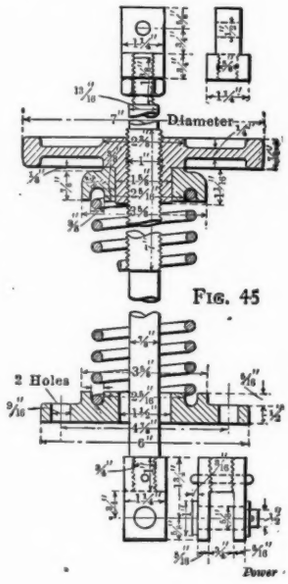


FIG. 45

FIGS. 43-45. GOVERNOR CASING, BRACKET AND SPEEDER GEAR

square brass blocks are placed, these engaging with suitable horns formed on the governor sleeve; see Fig. 40. At the other end of this sleeve are formed two collars, into which is fitted the trunnion ring, Fig. 40. This trunnion ring transmits the motion of the governor to the steel bell-crank lever, Fig. 42. The sleeve, Fig. 40, is of cast iron and is made a sliding fit on the crank-shaft end. Oil under pressure is admitted to the cavity in the center of the sleeve, and from this cavity the oil is led to the trunnion ring and sleeve blocks by the small holes shown. Thus, all the working parts of the governor are lubricated automatically by oil under pressure.

A detailed drawing of the governor casing is shown in Fig. 43. Two facings are provided at the top, one for the bracket shown in Fig. 44, carrying the bell-crank lever, and the other for the speeder-spring plate, see Fig. 45. A door is provided in the end of the casing to give

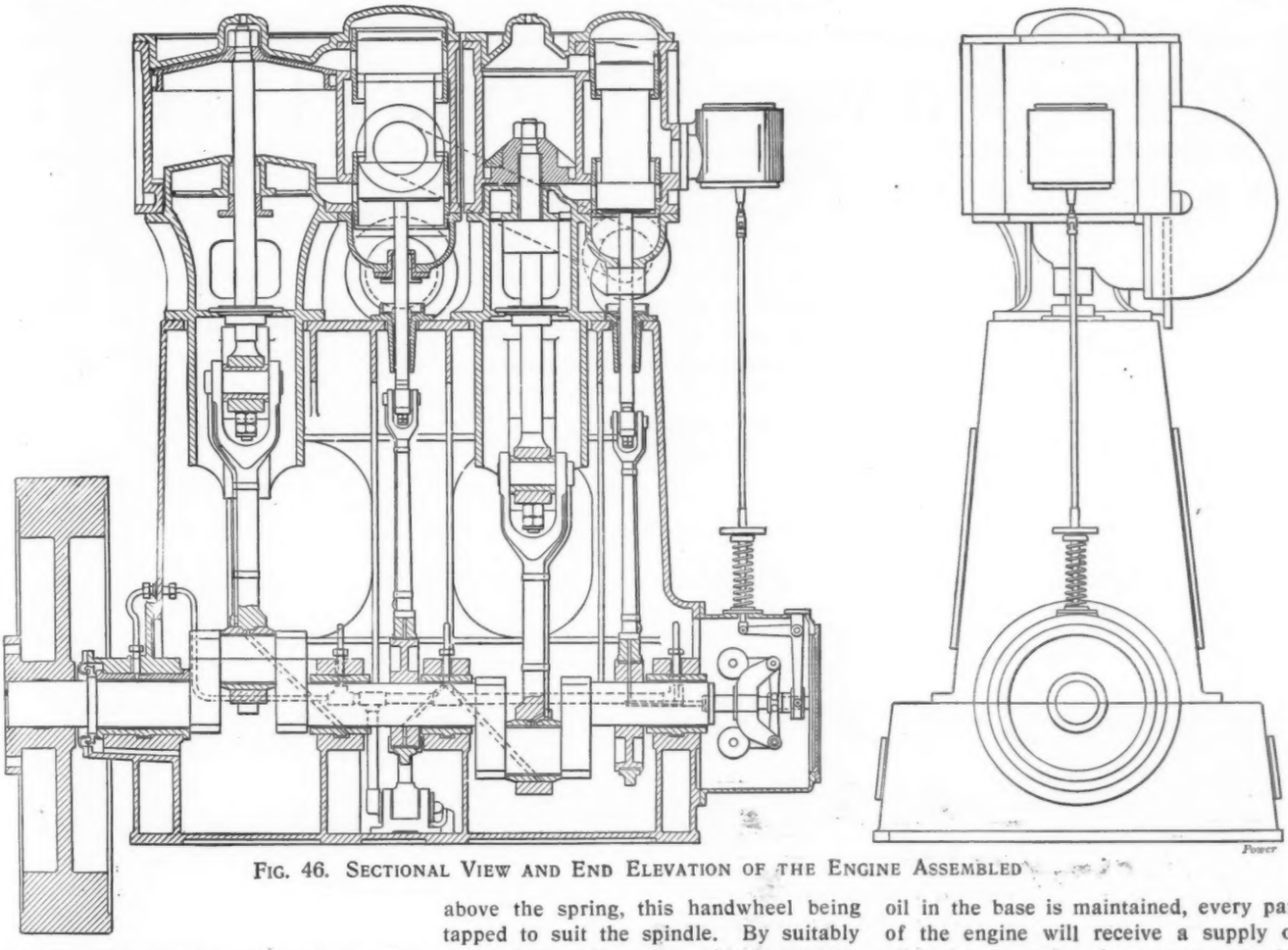


FIG. 46. SECTIONAL VIEW AND END ELEVATION OF THE ENGINE ASSEMBLED

access to the working parts of the governor.

The speeder gear is fitted so that the speed of the engine may be varied 5 per cent. while the engine is running. It consists of a compression spring, surrounding the connecting link between the governor and the throttle valve, which always tends to close the valve, and so acts against the governor springs proper. The compression on the spring can be varied by means of the handwheel shown above the spring, this handwheel being tapped to suit the spindle. By suitably proportioning this spring with the governor springs, the variation in speed is obtained.

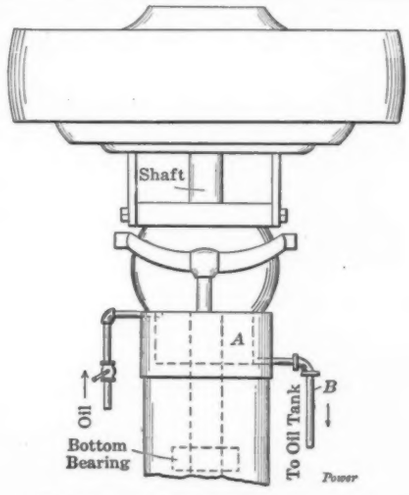
LUBRICATION

As previously stated, the lubrication of the engine is entirely automatic. Before starting the engine, the base is filled with oil to such a hight as to cover the top of the oil strainer about one inch. When the engine starts, the oil pump begins pumping; and so long as the level of the oil in the base is maintained, every part of the engine will receive a supply of oil under pressure. A pressure gage located outside the frame is coupled to the oil-delivery pipe, and by means of a small bypass valve, which allows the surplus oil to flow direct to the engine base, the pressure can be regulated at will. The usual pressure allowed is 20 pounds per square inch. The steam cylinders are lubricated by a separate mechanically driven force-pump type of lubricator. An assembled drawing of the engine is shown in Fig. 46.

Oiling System for Turbine Governor

The general practice in lubricating some types of turbine governor is to oil the top bearing supporting the governor spindle, just below the forked arm connecting the valve-regulating levers, and depend on the oil running down the shaft to lubricate the bottom bearing.

In one instance, the engineer in charge of a steam turbine in the city of Richmond, Va., worked out a means of effectually lubricating the lower spindle bearing of the governor on the turbine unit, by leading a small brass pipe from the return oil line from the main bearings to the upper bearing of the governor, as shown in the accompanying illustration. The incoming oil entered at the top of the collar *A* and discharged through the pipe *B* into the storage oil tank at the end of the turbine. In this manner the slight pressure of the oil in the return pipe from the bearings was sufficient to force the oil up through the pipe to the upper bearing of the governor, but not in such quantities as to cause the oil to fly. As the cup *A* is always partially filled with oil, so long as the bearing oil for the main bearings of the turbine is in circulation, the bottom bearing of the governor shaft is always well oiled, thus eliminating all trouble from lack of proper and sufficient lubrication.



PIPING TO GOVERNOR BEARINGS

It is always a good plan to keep the gage cocks in good order and use them. Place tees or crosses at the bend of both pipes from the boiler to the water column; remove the plugs and clean these pipes when washing out the boiler.

Gas Power Department

A Small Power Plant with Modern Features

By L. L. Brewster

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

The plant herein described is one of several power stations of the Standard Oilcloth Company and is located between Peekskill and Montrose, alongside the tracks of the New York Central & Hudson River Railroad Company. The plant was installed under the advice and direction of the Loomis-Pettibone Company, consulting engineers, of New York, and the choice of apparatus was made before the designs for the building and the layout of apparatus were begun. The result of this procedure is a most complete and harmonious plant, the operation of which affords evidence of careful and competent design.

The building is a handsome structure of red brick and molded concrete trimmings, with a concrete floor and a reinforced-concrete roof supported by a steel skeleton frame. The wall columns support the track for a 7½-ton Cleveland crane, shown in the picture of the engine room. The engine-room walls are faced with light gray impervious brick, and four monitor skylights extend nearly the entire length of the room.

On account of the character of the subsoil it was found necessary to lay a slab of concrete three feet thick entirely over the area inside the engine room.

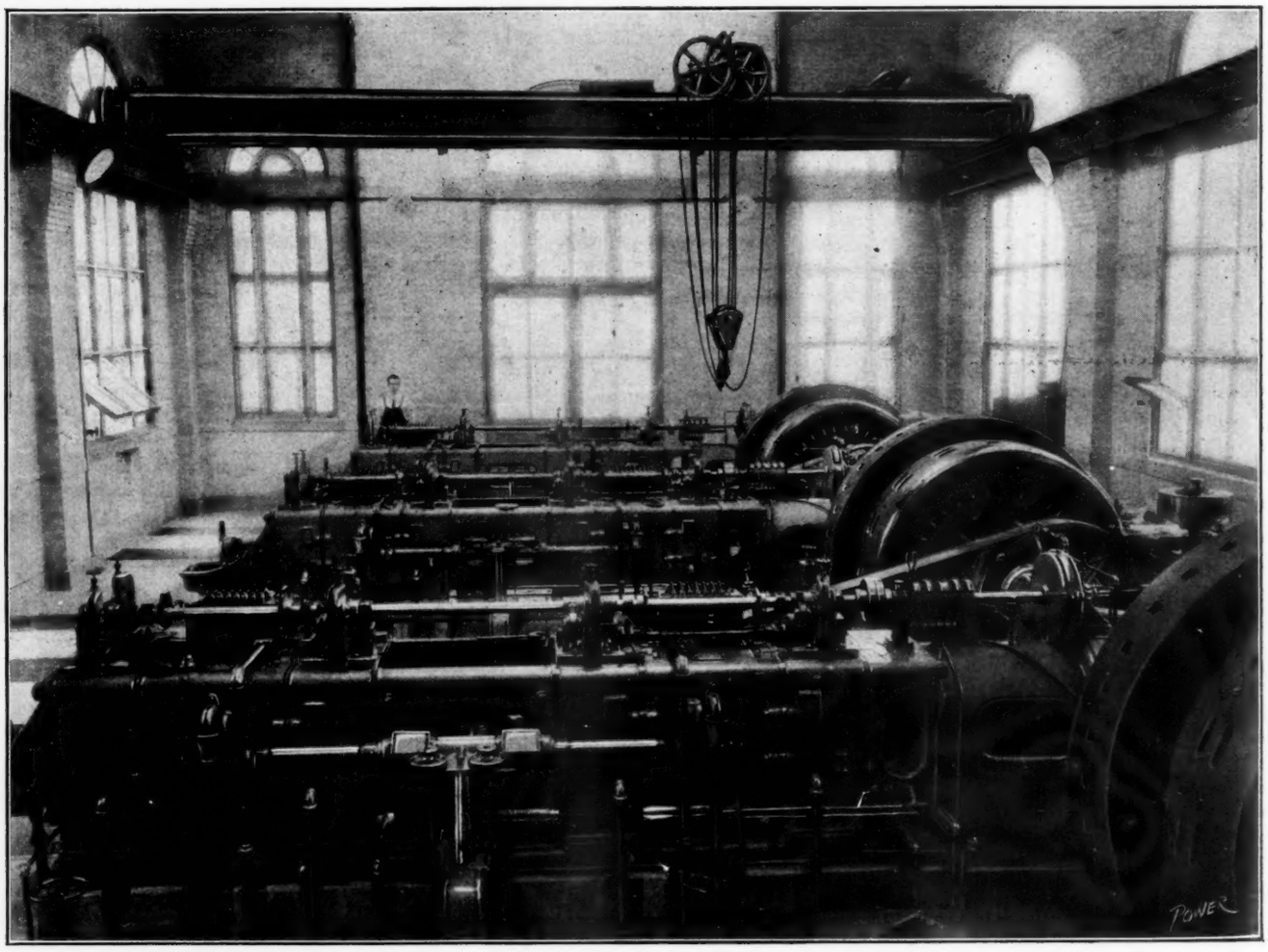


Fig. 1. The Generating Units in the Power Plant of the Standard Oil Cloth Company

Producers

The producers are operating on bituminous coal and are the Loomis-Pettibone down-draft single-generator type, built by the Power and Mining Machinery Company, of Milwaukee, Wis. There are two 7-foot generators, and each generator has a lining 13½ inches thick and is rated at 250 horsepower. The grate area of each generator is about 17.72 square feet, or a trifle over 0.07 square foot per rated horsepower. The generators are 12 feet 6 inches high. After leaving the generator, the gas passes first through an air preheater 3 feet 2 inches in diameter by 13 feet high, which serves not only to heat the air going to the generators but also to produce the steam to be admitted with the air to the fuel bed. The amount of water delivered to the preheaters is regulated by hand.

From the preheater, the gas goes to the wet scrubber or more properly cooler, 30 inches in diameter by 15 feet 6 inches

high. The scrubbers are supplied with water through spray nozzles at a pressure of about 35 pounds per square inch.

fore me, but they run considerably below 0.02 grain per cubic foot.

A study of the producer layout, Fig. 5, will show that either producer can be served by either exhauster or both producers and both exhausters can be operated simultaneously. Each producer has sufficient maximum capacity to supply the full engine capacity of 500 horsepower.

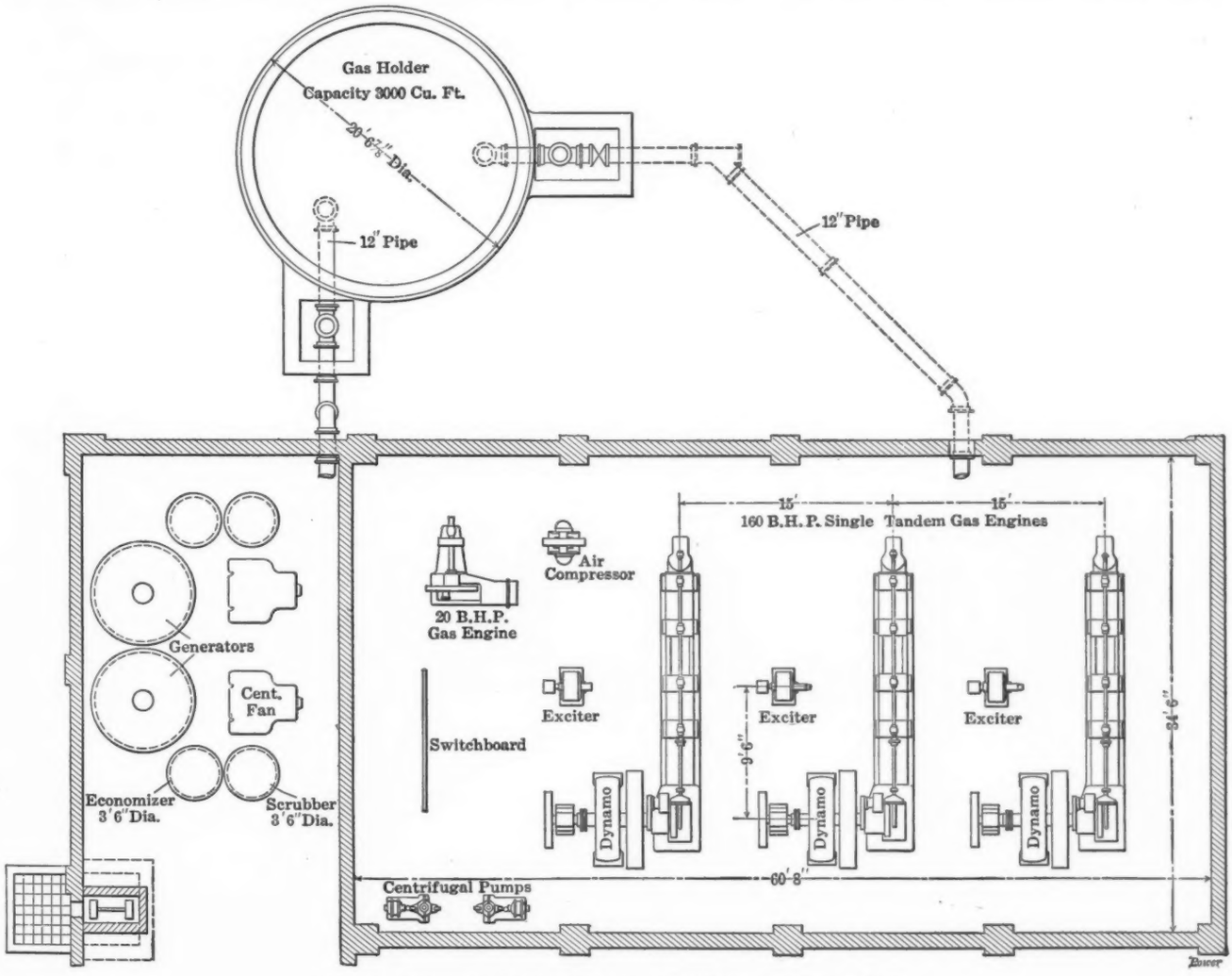


FIG. 2. GENERAL LAYOUT OF THE COMPLETE POWER PLANT

Several nozzles are used, and they are distributed around the body of the scrubber. No coke or other distributing material is used in the coolers, but the extremely well divided spray throws down a large percentage of the dust contained in the gas.

After the gas leaves the static scrubbers it passes to centrifugal washers and exhausters, consisting of turbine blowers, furnished by the General Electric Company, capable of delivering against any pressure up to about two pounds gage. These blowers run at 3600 revolutions per minute, and are driven direct by 20-horsepower induction motors. The blowers are equipped with atomizing spray nozzles and supplied with water at about 35 pounds pressure. Both as exhausters and gas cleaners they have proved very efficient.

It is very evident that the engineers have appreciated the importance of thoroughly cleansing the producer gas and have provided the requisite apparatus to do it well. Tests show the dust content to be very low; the figures are not be-

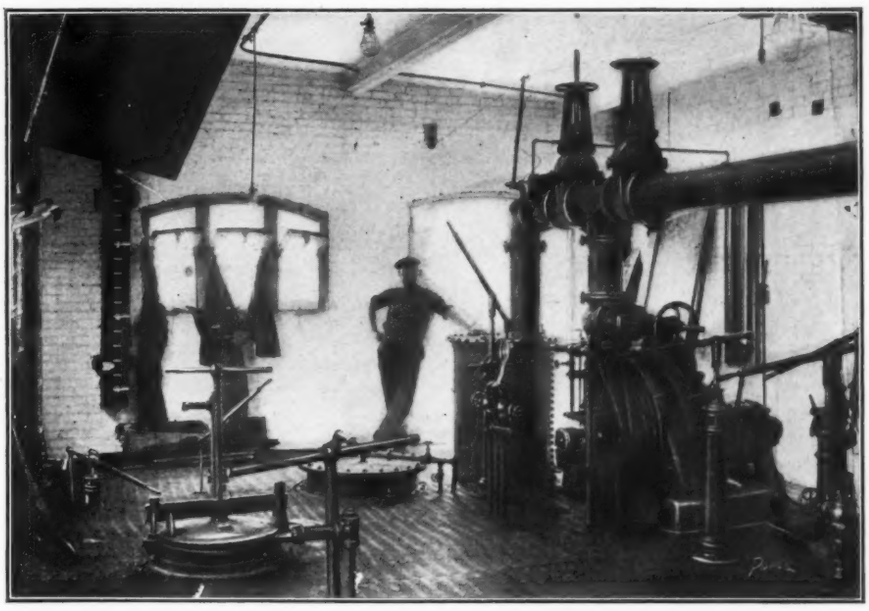


FIG. 3. PRODUCER CHARGING FLOOR

Coal is delivered in cars to the rear of the power house, where it is dumped into a hopper behind the producer room and elevated to the charging floor by a motor-driven bucket elevator furnished by the Link Belt Engineering Company. Spouts deposit the coal on the charging floor at any point desired.

The exhausters discharge into a common 12-inch main leading to a gas holder of 3000 cubic feet capacity, which serves more as a pressure regulator than as a reservoir; its contents would be consumed in less than four minutes by the three engines running at full load. Its function as a regulator is, however, very important, especially as the three engines drive direct-connected alternators in parallel, and with gas coming to each engine at constant pressure parallel operation is accomplished without any difficulty whatever, because one engine cannot rob another of gas.

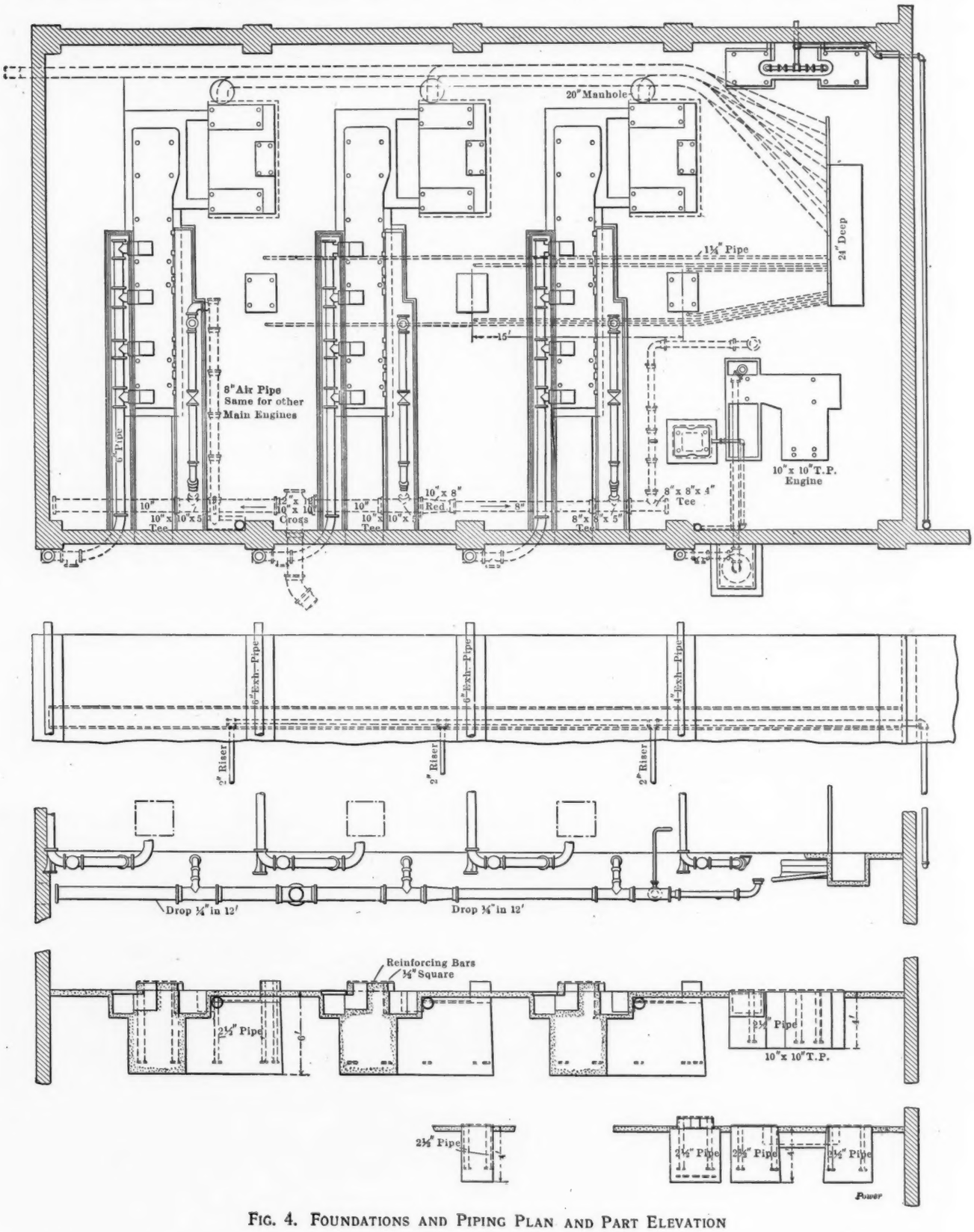


FIG. 4. FOUNDATIONS AND PIPING PLAN AND PART ELEVATION

The piping from the holder to the en-

gines is of cast iron with bell and spigot joints. Outside the power house it is laid in the ground and inside the house it is placed in trenches which are covered with steel plates. Figs. 4 and 5 give the pipe sizes.

In the Engine Room

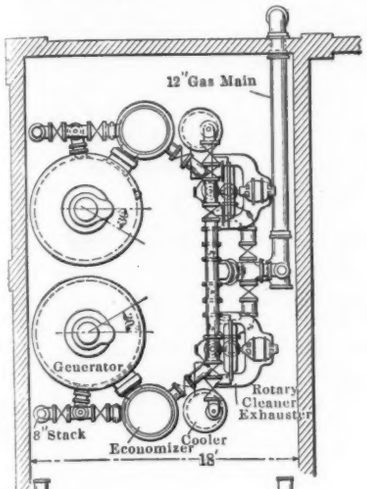
The engine equipment consists of three double-acting tandem units of 160 horsepower each and a small auxiliary single-cylinder single-acting engine of 20 horsepower, all of which were furnished by the Riverside Engine Company, of Oil City, Penn. Each main engine is direct connected to a 100-kilovolt-ampere alternator and belted to an exciter unit; Fig. 6 illustrates this arrangement. All the electrical apparatus, including the switchboard, was furnished by the General Electric Company.

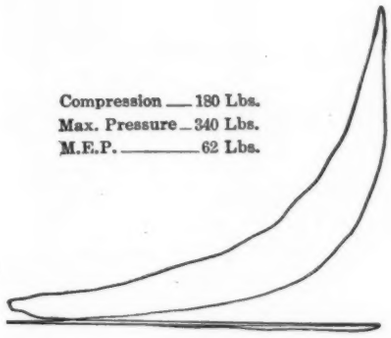
The auxiliary engine is belted to a 6x6-inch Ingersoll-Rand compressor and also to a 1-kilowatt, 125-volt direct-current generator, as shown in Fig. 9. This generator supplies ignition current to the engines through the ignition switchboard shown to the left of the main board in Fig. 10, but there are two other sources of ignition current, namely, a Westinghouse 120-volt storage battery and the exciter busbars. In case of a total shutdown, the battery would be used for starting and if sufficient gas had not been retained in the holder to supply the auxiliary engine, gasolene may be used.

All of the engines are ordinarily started by means of compressed gas instead of using compressed air as is commonly done. The belted compressor delivers compressed gas into a steel tank, 54x 96 inches, at about 125 pounds pressure, and from this source the engines are started and the producers are reverse-blasted at intervals.

A view of the main engines is given in Fig. 1 and their relative locations are shown in Fig. 2. The cylinders are 15 inches in diameter, the stroke is 16 inches and the engines run at 225 revolutions per minute, which gives a piston speed of 600 feet per minute. They are of the standard Riverside design and are fitted with Jahns centrifugal governors.

The warm discharge water from the cylinder jackets is delivered to the piston rods at the intermediate crosshead, from which point the water flows in opposite directions through each rod and piston. A pair of telescopic joints convey the water to the moving crosshead. This use





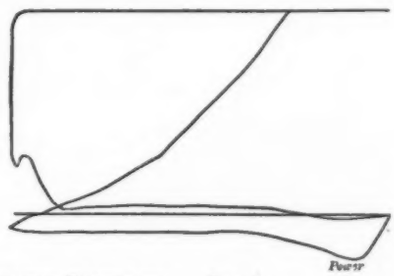


FIG. 7 COMPLETE AND STOP INDICATOR DIAGRAMS FIG. 8

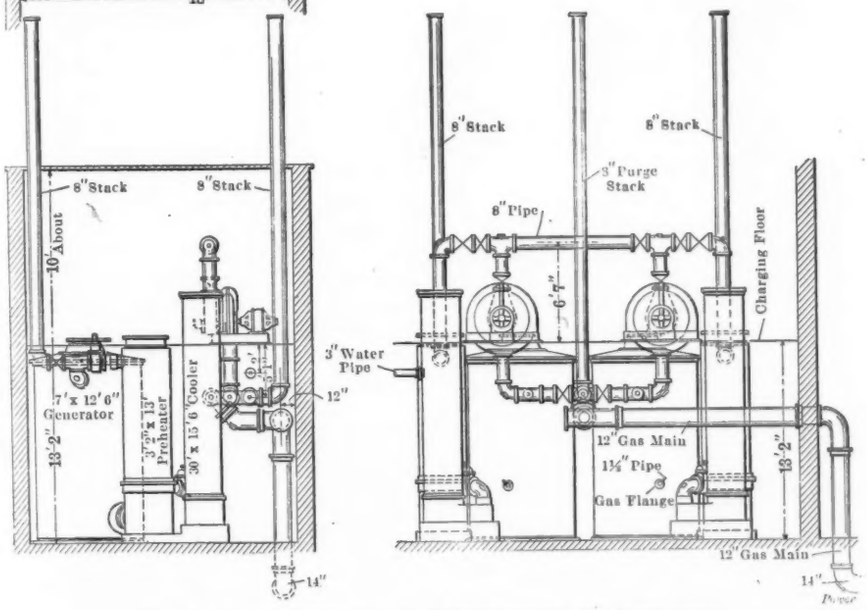


FIG. 5. ARRANGEMENT AND CONNECTIONS OF PRODUCERS

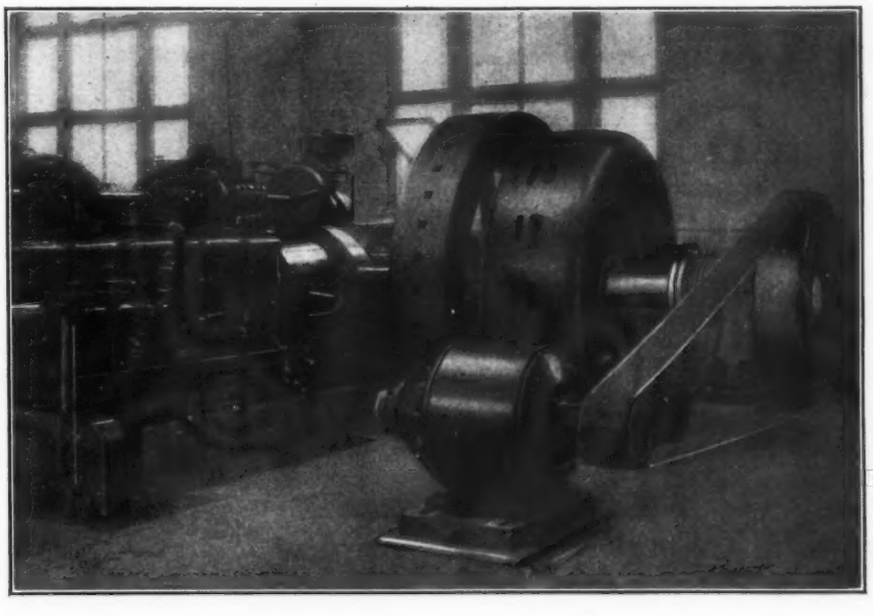


FIG. 6. AN ALTERNATOR AND ITS EXCITER

of warm, instead of cold, water in the piston rods, together with the use of a special steel in making them, has cured rod wear due to chemical action.

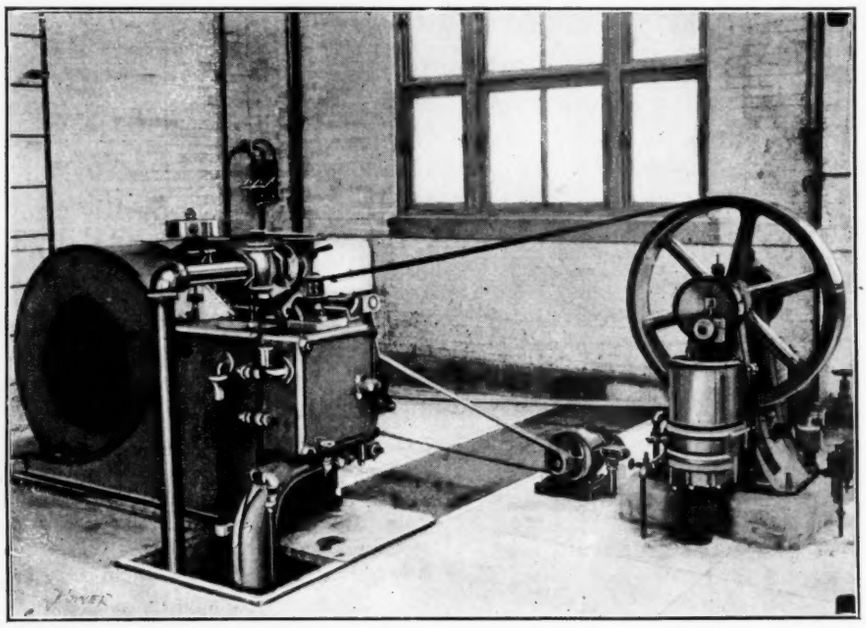


FIG. 9. AUXILIARY ENGINE, COMPRESSOR AND DYNAMO

The gas made in this plant has a heat value of 110 to 120 B.t.u. per cubic foot, the hydrogen percentage being usually low. The explanation is that very little steam is delivered to the producers. With the high engine compression used, however, a very good efficiency is obtained and there is an almost complete absence of back firing. Advantage was taken of these gas characteristics to build the engines for high compression. Fig. 7 is an indicator diagram taken when the load was not maximum, the mixture being slightly throttled, as shown by the stop diagram in Fig. 8.

Any two or all of the three units may be operated in parallel without difficulty. This is, of course, due largely to the freedom from back firing, and also to the supplying of gas at uniform pressure, without pipe-line surges or pulsations.

The speed of each engine may be varied by hand over a considerable range by means of an auxiliary spring and adjusting lever connected to the governor as shown in Fig. 11. By moving the lever over the latching segment, more or less tension is put upon the auxiliary spring, which augments the main governor spring. Moving the lever downward increases the speed. This device facilitates synchronizing the generators and also serves to adjust the proportion of the load taken by each engine. The picture also shows the method of driving the governor and the cam shaft by a drag crank from the main crank pin. All of the driving mechanism is supported solidly on the heavy engine bed and is not affected by any misalinement of the main shaft. Furthermore, the speed of the governor is not affected by momentary irregularities in the cam-shaft velocity.

Water for the engine jackets and the scrubbers is furnished by a duplicate outfit of Watson-Stillman motor-driven twin-volute turbine pumps. Each of these pumps is rated at 9000 gallons per hour, delivering against 40 pounds pressure. The pumps draw water through about 325 feet of suction pipe with a total lift of about 10 feet. They can be primed one from the other, or by gravity from the water in the gas holder, to which they are also connected.

All the lubrication in the engine room is supplied from a Unit type oil filter furnished by the Burt Manufacturing Company, Akron, O. The filter is placed about 20 feet above the floor and the used oil is delivered to it by a small motor-driven Lobee rotary pump. The clean-oil compartment of the filter furnishes sufficient oil storage capacity. All oil used in the plant, except the cylinder oil, is drained to a common tank below the floor level from which it is elevated by the pump to the overhead filter.

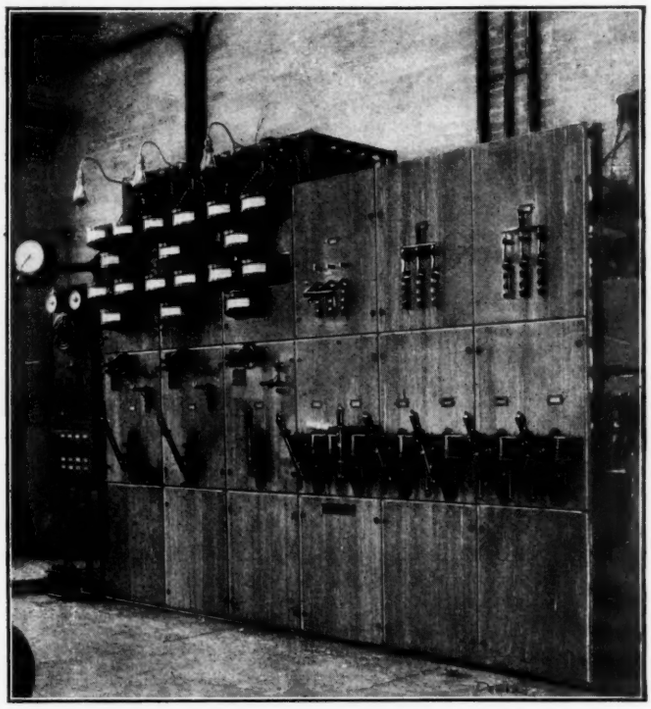


FIG. 10. THE SWITCHBOARD

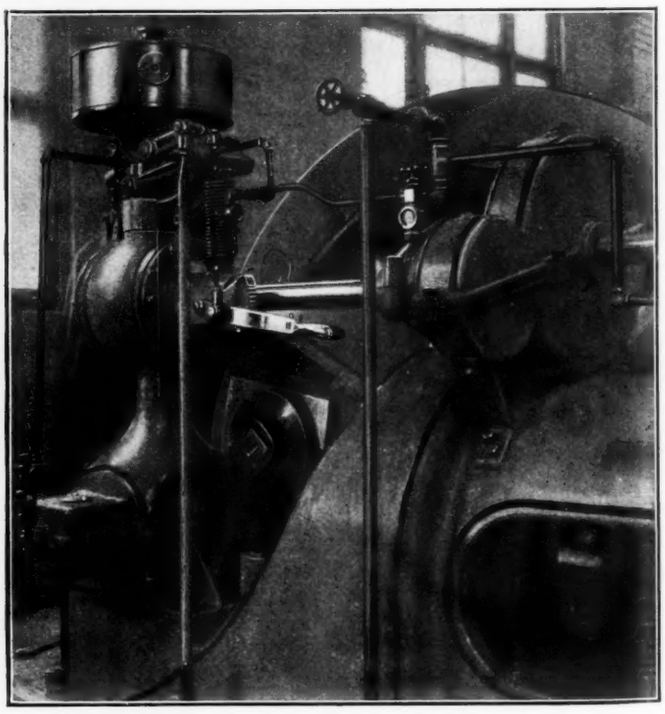


FIG. 11. GOVERNOR MECHANISM

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

Why the Regulator Wouldn't Regulate

By F. G. Heckler

It is well known that machinery depreciates when standing idle, but that a variable-speed controller for a 6-horsepower direct-current motor used for driving an Olsen oil-testing machine should fail to operate properly after three months' vacation was hardly to be expected.

The face of the starting box is shown in Fig. 1. The line current is brought in on the arm *A;* the field current is shunted through the contact strip *F*, passes through the magnet *M* and thence, by way of the binding post *B*, to the motor field winding. By moving the arm *A* to the right over the contacts *C*, *C'*, *C''*, *C'''*, the resistance in the field circuit is increased, which increases the speed of the motor. Attached to the arm is a strip *L* with a number of shallow grooves cut across its upper side. The field current in the magnet *M* magnetizes the core and attracts the armature *N*, pivoted at *P*, and presses the strip *L* against the knife edge *K*, which catches in the grooves across the strip *L* and thereby holds the arm in position for any desired speed from 800 to 1600 revolutions per minute.

The magnet held the arm in place, but it was impossible to get any increase of speed until the last step C''' was reached, when the speed would suddenly jump to its maximum value. It was noticed that in shifting from one contact point to another there was always sparking between the magnet core and the armature, indicating that there was current passing between the two, and this gave a clew to the trouble. There was a ground in the magnet winding which allowed the current to pass freely through *L*, *O* and *N* to the motor field winding, and the field current, therefore, was not decreased when the arm was moved to the right over the contact buttons to increase the speed. It happened that when the arm *A* was on the last contact button the air-gap between the core of the magnet *M* and its armature *N* was increased, preventing the passage of any current. This accounted for the increased speed at this point.

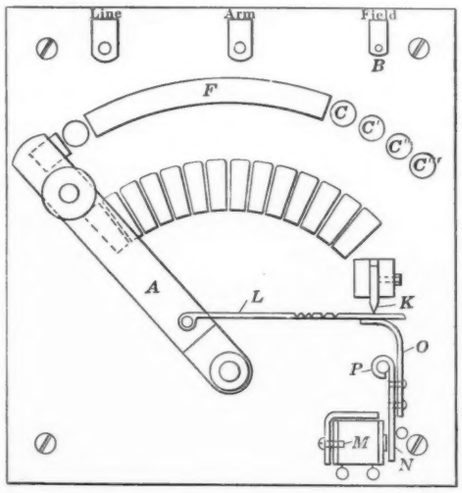


Fig. 1. Mr. Hecker's Motor Controller

Fig. 2

It was necessary to make at least a temporary repair immediately, and this was easily done by removing the extension *O* of the magnet armature and inserting between the two pieces, *N* and *O*, a piece of fiber, as shown in Fig. 2. The holes in the piece *O* were enlarged to permit the insertion of fiber bushings around the screws to insulate the shanks, and a strip of fiber under the screw heads insulated them there. This repair was made in a short time and avoided the delay of securing a new magnet.

Some Reminiscences of an Old Construction Man

By A. E. Walker

Some years ago I was engaged with a firm of electric-light contractors, who fitted up a number of small private installations mostly driven by gas engines supplied with town gas, there being at that time no public supply of electricity available in the town. In the course of my three years' experience with the company, I helped to install a number of these plants, and often had to run them for a few days until the gardener, coachman, errand boy or chief cook and bottlewasher felt quite at home with the equipment and could take charge.

Of course we were often sent for to find where the trouble was when anything went wrong, and some of the mishaps were very amusing.

One private house was in the dark all night because the gardener-electrician hadn't noticed that the bottom brush of the dynamo had fallen out onto the floor, there being only one on each stud and the machine being bipolar. We were, of course, called up in the morning, and the gardener related his woes, how he had put more oil on the bearings, put a new ignition tube in the engine, and tried every other stunt he could think of! His face was a picture when the real cause of the trouble was pointed out.

Another plant we fixed up consisted of a 15-kilowatt gas-driven dynamo and a storage battery. There was an automatic switch on the positive terminal of the dynamo which cut the machine in as soon as it came up to a high enough voltage to charge the battery, and cut it out if the voltage dropped.

A knife switch was also provided at the negative terminal to be opened when the dynamo was shut down, as a safeguard against the automatic switch being closed by accident.

One day the attendant shut down the dynamo and forgot to pull out the knife switch, and as luck would have it, someone got fooling around the engine room while he was away and pushed the automatic switch in. Results: Switch burned up, dynamo and battery fuses blown and a lot of plates in the battery badly buckled.

We once had a compound-wound dynamo sent into the shops to have a new coil put into the armature and be generally overhauled. When we got it together again and on the test block, belted to a gas engine, it refused to excite. The dynamo pulley was small for the belt

speed of our driving wheel, so we were running the engine slowly to get the right speed on the dynamo. The foreman then had the engine run up to its normal speed which made the dynamo run about 50 per cent. fast. Still no signs of any juice on the bank of lamps or the voltmeter connected across the terminals.

All the wire ends were led to one terminal board on top of the machine; so it was easy to get them mixed. We had a council of war, and the foreman said the series winding was opposing the shunt, but I said it wasn't; however, he tried crossing over the series without any effect, so put it back; then he said she must have lost her residual magnetism. I suggested that perhaps the shunt current was opposing the residual magnetism, and after a lot of argument he said he would cross it over just to show me I was wrong. He did so, and immediately he got the last wire end into the terminal up came the voltage, and with the dynamo going at increased speed nearly blew all the lamps to bits, every lamp looking like a small arc.

Unbalanced Airgaps

By R. A. Cultra

The articles published in recent issues of Power under this title seem to apply to induction motors only. A good deal of trouble, however, can be caused by unbalanced airgaps in dynamos, especially direct-current machines. I had a 525-kilowatt direct-current generator in a power plant which behaved quite badly. The voltage fluctuated excessively and the brushes sparked some, and, although nothing indicated any very serious trouble, the machine ran very unsatisfactorily. After shutting down one night, while examining the brushes and brush-holders, as usual, I noticed that the bottom holders were much closer to the commutator than the top ones, and I then measured the distances from the armature core to the polefaces, top and bottom; the airgap below the armature was about ⅛ inch and the one above it was about ¾ inch.

The engine was a cross compound and the bearing surface of the boxes had been criticized as insufficient by numerous mechanical engineers who had visited the plant. These boxes had always run very warm and the length of each one was barely two diameters of the shaft. The neglect of the oilers, combined with the inadequate bearing surface, had caused the babbitt to wear very thin in the bottom shells, lowering the armature and producing an unsymmetrical airgap. The armature did not strike the polefaces but it would have done so if allowed to run much longer.

Large shims were made to slide under the bottom halves of the boxes, and enough of these were put under the shells to center the armature between opposite polefaces. The result was much more than expected. Although the armature had been centered only for the purpose of preventing it from striking the magnet poles, we discovered that the machine ran very steadily and without sparking after this was done. Of course, after the difference in operation was noticed, it was easy to reason out the cause, which was the inequality between the electromotive forces generated in the different branches or paths of the armature winding.

LETTERS

Mr. Earle's Pump Motor Control

In reply to W. H. Earle's query in the September 6 issue, it is scarcely necessary to say that it is possible to rig up a water rheostat, but the expense and consequent trouble involved thereafter make it a very poor device for speed control. I would not consider it good practice at all to install a pump of the size he has without having a speed controller instead of the "usual form of starting box." An outfit of the capacity mentioned should have a speed range of from one-half to full speed. With a well designed controller, that is, one that does not increase in temperature too much at low motor speeds, the controller lever can be connected to a float in the sump so as to hold the water at practically any desired level. If the minimum speed of the motor is still too fast after the controller is put in, some dead resistance can be inserted in the armature circuit. Of course, it is much better to determine just what the minimum speed is to be and have the controller to regulate accordingly.

I would think that considerable trouble would result from trying to have a steady flow of water through the rheostat. I have yet to see the first circuit in a wet mine that was not troubled with numerous grounds, and the first time there was a ground on the opposite side of the line from the water rheostat, there would be a short-circuit on the line. If a water rheostat is used, it should be connected between the motor and the negative side of the line, as there will not be as much potential to ground as if connected between the motor and the starting box. I am assuming in this case that there is a trolley line in the mine and that the negative side of the system is grounded. If there is a two-wire circuit and no part of the system is grounded it will make no difference which side the rheostat is on.

I have one 8x8 triplex pump driven by a 30-horsepower 250-volt motor, and the speed range is from 500 to 1000 revolutions per minute. At the lowest speed the water is kept down nicely, but if for any reason it should be desired to run the motor at a lower speed, extra resistance could be inserted and the float and controller rigging could be put on, if it were desired to have the water level regulated automatically.

L. Earle Brown.

Roundup, Mont.

Mr. Earle is extending open arms to trouble for himself by considering the use of a water rheostat as described. I have had considerable experience with pumps operating under such conditions and have found that the best apparatus to be used is an automatic motor starter in the pump room, controlled by a float in the sump to start and stop the motor when the water has risen or fallen to certain predetermined levels in the sump. I know this arrangement will give satisfactory service if there is a good foot valve on the pump suction, whereas the water rheostat called for in Mr. Earle's letter will be a continual source of trouble.

W. H. Keller.

Ansted, W. Va.

Three Wire vs. Two Wire Generators

In his letter, published in the issue of September 20, Mr. Reynolds expresses the opinion that I am operating under conditions particularly favorable to the three-wire generator. This is not the case, even as to average conditions, and our conditions vary a good deal. I have at times an unbalanced load of 125 amperes and the voltage remains the same; we never see any fluctuations in voltage. At times an elevator load of 400 amperes comes on all at once and this is not even noticed. I do not think it good practice to install two machines, giving each one half of the load, when one generator can do the work.

The three-wire generator, with collector rings and choke coils, is as simple as any other generator but a man must study the machine the same as he would any other one. In the March 15 issue of Power the three-wire generators of the Westinghouse and Western Electric Companies were fully described and diagrams of both were shown. All young engineers and electricians ought to keep posted on these generators for they are the coming thing.

Walter W. Smith.

Chicago, Ill.

A pulley of compressed paper pulp made in the form of a ring, sawed in two and mounted with hubs and arms of either steel or wood was exhibited at Brussels. It weighs considerably less than one-half what an iron pulley does and furnishes an admirable surface for the belt.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Wrong Valve Setting

A certain plant has a 300-horsepower noncondensing tandem-compound McIntosh-Seymour engine, belt connected to a direct-current generator which is held in reserve and operated only at times of heavy load. It was noticed that whenever this engine was operated, it seemed to pull the steam right out of the boilers.

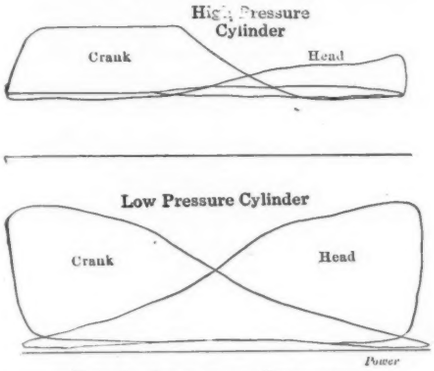


FIG. 1. INDICATOR DIAGRAMS

The engineer, who had not had charge of this plant very long, undertook to find out why this engine consumed so much steam. Indicators were put on and diagrams taken, samples of which are shown in Fig. 1. The diagrams obtained on the low-pressure end were fair but those on the high-pressure end were very peculiar.

It was thought that the steam valve was cutting off too early, consequently that was lengthened, but with no better results. Next, the main valve was readjusted, but still the cards were about the same. The covers to the steam chest were removed and the steam valves set correctly but still the cards were not much better. The covers to the exhaust

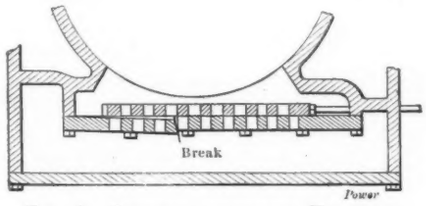


FIG. 2. SECTION THROUGH EXHAUST CHAMBER

chamber were then taken off and it was discovered that the exhaust valves were set so that they were open during admission; this allowed the steam to blow through them into the receiver, with the result that the low-pressure cylinder was performing most of the work.

Upon opening the exhaust chamber on the low-pressure cylinder, it was found that the exhaust-valve seat had become broken, and as the tap-bolts which held the seat in place had become loosened, the seat had dropped slightly and let steam past when the valve was closed. Fig. 2 shows the broken seat. When a new exhaust-valve seat had been procured and the valves set properly, the engine ran very economically.

It was learned later that the man who had formerly held the position of chief engineer had had occasion to take out the valves in the high-pressure cylinder and upon putting them back had experienced great difficulty in making the engine run. When he did finally succeed in making it run he was satisfied to leave the valves as they were.

GEORGE F. ATWATER.

South Norwalk, Conn.

Pump Packing Kinks

I had a pump with 8-inch water cylinders in which the packing wore out very rapidly. An examination showed that the brass linings of the cylinders had worn through on the bottom, leaving jagged edges which cut away the packing.

Removing the piston from the rod, I took some long cape and gouge chisels about ⅛ inch wide and chipped a groove through the remaining solid portion of the lining on the bottom and removed the lining. I then calipered the cylinder, measured the length of the sleeve and ordered a new lining. In order to use the pump I secured some tucks packing, about ⅛ inch thicker than usual, to make up for the thickness of the brass sleeve, and cut it into rings, beveling the ends to overlap each other. I then replaced the piston and the packing, put on the cylinder head and after packing the stuffing boxes started the pump which gave good service until the new brass sleeve arrived. Then, removing the piston from the water end as well as the packing in the stuffing boxes and the rocker-arm connection from the rod, I removed the rod through the steam cylinder and inserted a long 1-inch bolt, having a long thread at one end, into the steam cylinder in place of the rod. A large iron washer was placed against the end of the sleeve on the rod, and the nut screwed up until the sleeve was drawn into place. The bolt was then removed and the rod replaced, also the piston and packing, and the stuffing boxes were packed.

The second cylinder gave the same trouble a month later and the same treatment was applied, thus putting the water cylinders in excellent condition with the result that the packing lasted eight months. This will appear to the average engineer as a hard or impossible job to be accomplished away from a machine shop, but it is much easier when the piston has been removed.

R. A. CULTRA.

Boston, Mass.

A Boiler Feed Pipe Repair

Upon taking charge of the steam plant of a manufacturing establishment I made a tour of inspection with the owner and upon entering the boiler room he remarked, "These two boilers blow off at

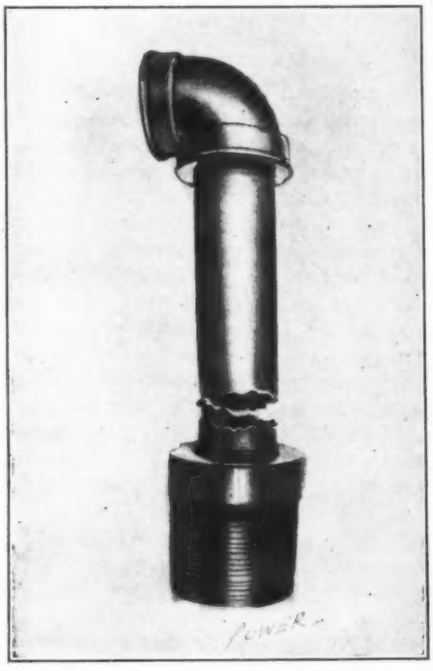


FIG. 1. BROKEN FEED PIPE

115 pounds pressure, the feed pipes leak badly at the boiler heads and they must be repaired. The boiler inspector is out of patience with us for neglecting them so long, and in his last report says they must be made tight before his next visit to our works."

Upon examination I found that the leaks were at the point where the brass bushings entered the front tube sheets

and, judging from the appearance of the iron feed pipes and the tube sheets, they had been leaking for a long time, as both were badly eaten away by the corrosive action of the escaping water mingled with the soot.

The next Sunday morning when I began to put in new bushings I was surprised to see the feed pipe break off when I undertook to disconnect it from the elbow. A picture of this broken feed pipe is shown in Fig. 1. At the point of fracture the pipe was only 1/32 inch thick on the under side and 5/32 inch on the upper side, and it is a mystery to me how the pipe withstood a pressure of 115 pounds per square inch without breaking.

Upon removing the bushings I found a portion of the tube sheet to be eaten away as shown at *J*, Fig. 2. This sheet had been only ½ inch thick when new and as the bushing had eight threads per inch, only two threads were available; this was insufficient to make a tight joint even with the new bushings.

I accordingly had the arrangement, shown in Fig. 2, made at a local foundry and machine shop. The brass bushing *B B'* extends from *B* to *B'* in order that nut *C'* may clear the diagonal stays. Locknut *C* has a cavity *I* to receive the packing. Sleeve *E* is slipped over the bushing *B B'* and has openings *K* to straddle the foot of the diagonal stay, also to furnish a bearing against the tube sheet at three points to prevent rocking. Nut *C'* is screwed onto the bushing and presses against the sleeve *E;* this reinforces the tube sheet and prevents the bushing from being pulled out when nut *C* is screwed against the packing in the the cavity *I*.

After the new fittings were installed, I wrapped the bushing with 3/16-inch packing, winding tightly in a clockwise direction and filling the cavity so that there was a space of 3/16 inch between the tube sheet and the nut; then the latter was screwed up tightly. We have had no more trouble with leaky boiler-feed pipes since making this change.

J. W. PARKER.

Clinton, Mass.

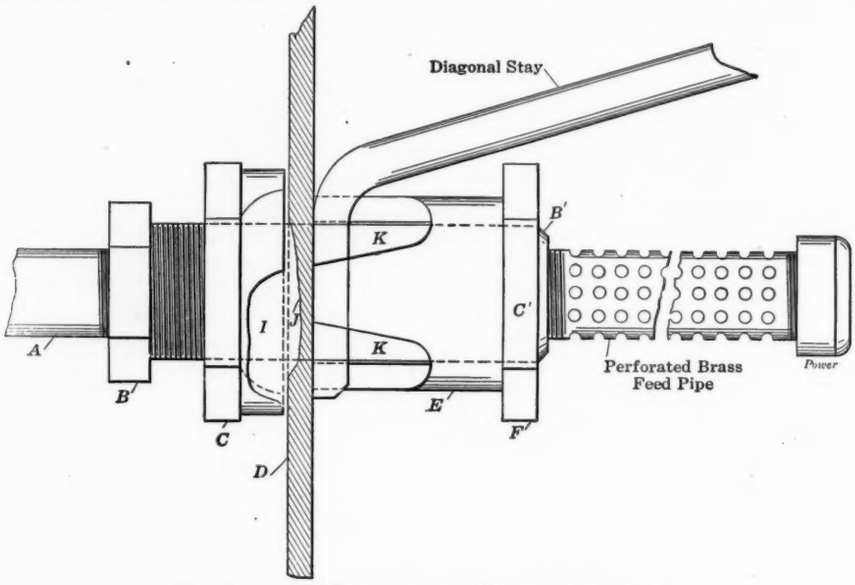
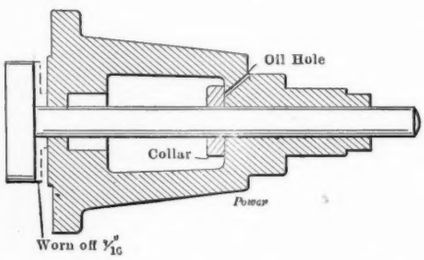


FIG. 2. SPECIAL BUSHING FOR BOILER-FEED PIPE

Corliss Valve Stem Repair

The valve stem was on the high-pressure cylinder of a 26 and 42 by 34-inch cross-compound Corliss engine which was new. From the beginning the valve had shown a tendency to groan, but it ran a couple of months before we noticed that this particular valve stem was projecting more than the rest. It constantly grew worse, until by the time we had an opportunity to dismantle the engine, the stem projected at least 7/16 inch. Upon removing the bonnet and valve stem we found that not only had the collar been worn off but also about ¼ inch of the T-head of the stem, although the bonnet against which it had rubbed did not show the slightest sign of wear. The stem was steel and the bonnet was cast iron. The stem was packed with metallic packing which leaked a little and the only way we could explain such unusual wear was that the water leaking through the packing had washed away the oil and thus caused the damage. The surfaces of the valve and the cylinder showed that they had been receiving sufficient oil.



COLLAR HOLDING VALVE STEM IN PLACE

The method of repair is indicated in the accompanying sketch. We filed the inner surface of the outside bearing of the bonnet square with the stem and fastened a collar on the latter with a set screw arranged so that the end thrust was taken up between the collar and the bonnet. We also drilled an oil hole through the bonnet so that we might be sure that it was getting the proper lubrication.

Most engines are fitted with such a collar, or its equivalent, when they leave the shop, so I do not make any claims for originality, but I believe it is better to have the collar outside of the cylinder than to have renewable rings inside.

A. E. MUELLER.

Mayville, Wis.

Filing Catalogs

Here is what I believe to be a good system of filing catalogs. First have a wooden box made about 5 feet long, 2 feet wide and 2 feet deep, in which to keep the catalogs. Pieces of white cardboard 2 feet square can be used to separate them. Number the cardboard partitions with large figures in red ink from one up to as many different classes of catalogs as will be handled. Then sort out the catalogs, placing those treating of the same subject in the same compartment.

For example—Suppose there are some catalogs on boilers, engines, electrical fittings, etc. Place those dealing with boilers after No. 1 cardboard, those dealing with engines after No. 2 cardboard, those on electrical fittings after No. 3 cardboard and so on. Another way is to place them in alphabetical order, in which case an index book should be kept similar to the following:

Name of Firm.	Subject.	Card Number.
Allis-Chalmers Co.	engines	5
Allis-Chalmers Co.	turbines	20
Allis-Chalmers Co.	pumps	16
Babcock & Wilcox Co.	boilers	2
Harrisburg Mfg. & Boiler Co.	boilers	2
General Electric Company	motors	13

Where there are catalogs of different firms treating of the same subject, it is well to place cardboard between each different catalog and mark each with the first letter of the firm's name. These cardboards should be made a little smaller than the others; this will make it easier to find the cardboard which is wanted.

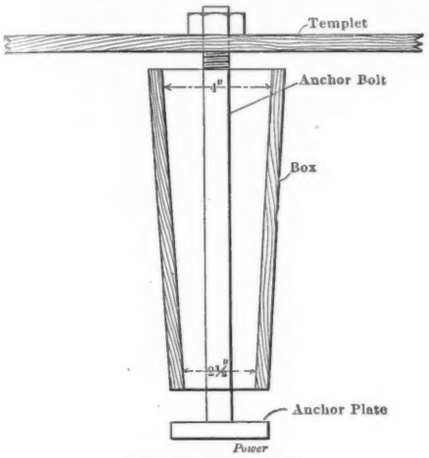
A system such as the foregoing saves considerable time as it does away with looking over the whole collection of catalogs to find the one wanted.

HENRY H. CANTOR.

Sheboygan Falls, Wis.

Inserting Foundation Bolts

Engineers use various forms of boxes and pipes around anchor bolts in engine foundations. About the best that I have seen came under my notice recently in the setting of foundations for two 360-horsepower engines. The erecting engineer had four boxes made of 1-inch boards which were long enough to reach



SECTION OF FORM

from the templet to within 2 inches of the anchor-bolt plates; these boxes were 2½ inches square at the bottom, and 4 inches square at the top, inside measurements. After assembling the boxes they were put under water and left for two days in order to swell them. Then they were slipped over the anchor bolts with the small end down. As the foundation dried out the boxes gave up the moisture in them and contracted, becoming so loose that it was an easy matter to lift them out of the foundation. When the engines were set, every crevice around the bolts was filled with cement, this making a better job than by placing pipes around the bolts.

W. H. KELLER.

Ansted, W. Va.

Municipal Ownership

Has a municipality the constitutional right to own and operate public utilities for the benefit of its citizens; has it the right to construct and maintain power plants for the purpose of supplying the city with electrical energy for light and power; has it the right to install a water system for the use of its residents; in competition with privately owned and established corporations?

The equity of municipal ownership, and its limitations based on state-constitutional provisions, are in litigation in the courts of California. San Francisco with the hetch-hetchy water scheme, Los Angeles with the aqueduct hydroelectric-power project, the city of Imperial with designs for a self-controlled water system and the municipality of Madera with like contentions, are engaged in legal suits to test the interpretation of the law. The latter, the most diminutive of the group, has been assisted by the others in its water-works case, which directly involves the general principles for which all are contending.

The decision in this litigation given by Judge Wellborn, of the United States District Court, on September 13, is of significant importance to municipalities throughout the country. He says in part:

"Both reason and authority sanction the doctrine that whatever the nature and extent of a franchise, restriction of legislative power is in issue; no matter through what agency of government the franchise was conveyed, whether a constitutional convention, a legislature or a municipality, the rule of strict construction against the grantee uniformly prevails, it must be held that the complainant's franchise does not shut out municipal competition. By no rule of construction, however, whether literal or in favor of the public, or such as applies to the ordinary agreements between individuals, can a different conclusion be reached. If it were ever permissible to enlarge by implication the grants of special privileges affecting the general interests, where can there be found in the case at the bar any justification for such an enlargement?"

This considerate judgment is far reaching; it has given an impetus to the remaining actions and the outcome will be of wide general interest. As in the course of such events, the Madera case will find its way to the Supreme Court, which tribunal, up to this time, has always sustained the decisions of Judge Wellborn.

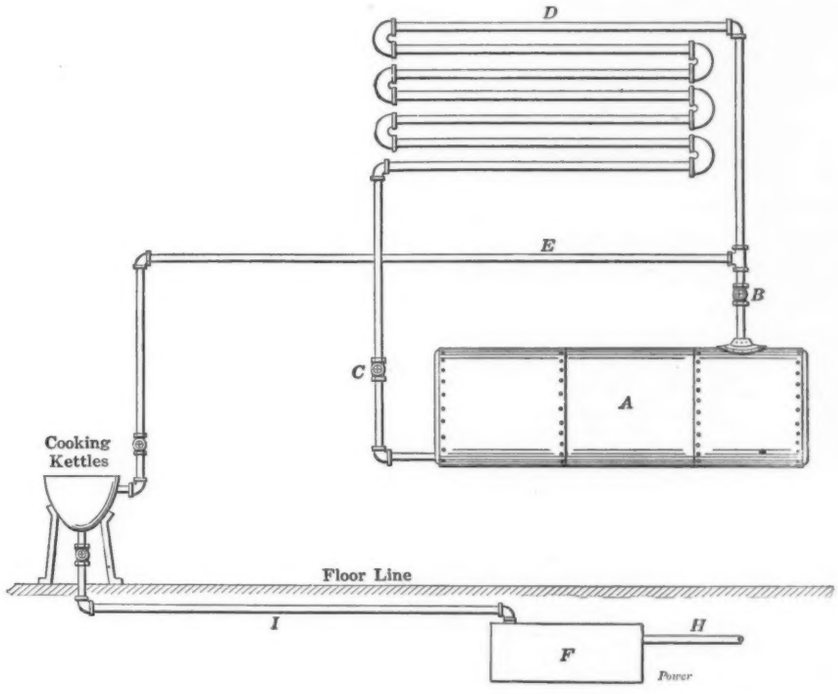
L. R. ALLISON.

Los Angeles, Cal.

Disappearance of Water in a Boiler

An inexperienced man was placed in charge of a steam-heating plant, part of the equipment being arranged as shown in the accompanying diagram, in which *A* represents the steam boiler, *B* the main stop valve, *C* the main return steam valve, *D* the heating coils and radiators, *E* the steam piping leading to the jacketed cooking kettles, *F* the hotwell receiving the condensation, *H* the overflow to the sewer and *I* the return to the hotwell from the kettles.

To make some repairs in the pipe work, valves *B* and *C* were closed, and when the repairs were completed *C* was opened and through neglect on the part of the inexperienced attendant *B* was left closed. A number of the valves on the kettles were open and there were no check valves on the returns from the radiators. When the pressure began to rise in the boiler the water was forced up the return, through the radiators, along pipe *E*, through the kettles to the hotwell and thence to the sewer. As a result great excitement prevailed for a time in the building; no one could tell where the boiler water was going. The city pressure was turned into the boiler, but the water went out faster than it could be put in. The fire was hastily drawn and an experienced man sent for. When he arrived, he located the trouble in a few minutes, and the owner concluded that it was wiser and safer to employ an experienced man to look after the plant.



ARRANGEMENT OF PIPING

JAMES E. NOBLE.

Toronto, Canada.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Frost in the Engine Room

In the August 23 issue, Mr. Fenwick states that he experiences much trouble with frost in his engine room. I believe this is due to the galvanized-iron roof; the vapor in the engine room is condensed, and in very cold weather it freezes on the underside of the iron covering. When the inside temperature is sufficient to thaw this accumulated frost, the water drips over everything.

I have the same conditions and experience the same trouble. The only remedy is a layer of felt under the iron roofing. Cooling the engine room by opening the outer door will stop the drip, but this is objectionable when the temperature is very low.

I would not, on any account, advise an air duct to the ashpit. Air at a very low temperature is not wanted below the grates; in fact, I believe that the air should first be heated in some way by the waste gases.

I have seen frost all around the ventilators on the furnace doors with the fires going full blast and all the doors and windows closed.

JOHN L. SHELDON.

Prince Albert, Can.

In the August 23 issue, Mr. Fenwick raises the question as to the cost of frost accumulating upon the walls and ceiling of an engine and boiler room.

In the first place, what are the necessary conditions to produce frost? In the case of air and water vapor we find that for each particular temperature there is a maximum density and if we compress vapor beyond this density, a portion of it will be liquefied. This is known as the saturation pressure. Also, for each pressure there is a minimum temperature and if we bring the temperature of the vapor below this, condensation will take place. This temperature is known as the condensation temperature or dew point. To state this in another way, we may say that if air is at its dew point, any decrease in temperature or increase in pressure will cause liquefaction. If the surface on which this condensation falls is at a low enough temperature, heat will be withdrawn from the liquid until it congeals and forms frost such as may be seen at any time on a bare brine pipe in a refrigeration plant.

Applying the above to the problem under discussion, it is evident that the air in the building, which, due to radiation from boilers and engines, is presumably at a temperature of about 60 degrees, will, on rising and passing near the walls and ceiling, be cooled below the dew point by radiation from the walls, which are extremely thin, and by mixing with outside air entering through crevices as suggested by Mr. Fenwick. The moisture thus deposited on the walls and ceiling is rapidly turned to frost, due to the heat in the liquid being radiated through the walls.

The only method of preventing this deposit of frost is to so increase the nonconduction of the walls and ceiling either by another thickness of boards so placed as to have a 6- to 8-inch dead-air space between, or by good nonconducting sheathing, that the walls will not be able to radiate heat fast enough to bring the temperature of the air below the dew point.

W. L. DURAND.

Washington, D. C.

Water in Superheated Steam

While there is no doubt that good judgment must be used in applying a calorimeter to a steam line if the average quality of the steam passing through it is to be correctly indicated, I think that W. H. Booth's statement on page 1501 in the August 23 issue, that "All calorimeter tests are, therefore, a delusion, unless they are made on superheated steam," is rather broad and misleading.

Why should not a calorimeter test of superheated steam be as liable to error as one made of saturated steam? It is evident that Mr. Booth wishes to imply, if he does not directly so state, that water and superheated steam cannot exist in a pipe line at the same time. This is, however, not a fact, as many engineers of wide experience can testify, for it is not an unknown fact that trouble has been caused by water in pipe lines which carry superheated steam. That the presence of water and superheated steam together in a pipe line does not conflict with any of the theoretical considerations of the subject, was most ably pointed out in an editorial published in the August, 1907, issue. As a means of illustrating the point, attention was called to the fact that ice cannot long exist in an atmosphere above 32 degrees Fahrenheit, but still we have the ice man with us, who delivers his goods in an open wagon through the streets, in the hottest days of summer. Water can be delivered through a pipe line that is carrying superheated steam in the same manner, the only requirements being that the water be not in a too finely divided state, and that the time of contact between the water and the steam be not too great. I do not believe that a thermometer can always indicate what is passing through a pipe carrying superheated steam as definitely as a good calorimeter, intelligently applied.

J. E. TERMAN.

New Haven, Conn.

A Problem in Economy

I read Mr. Lewis' letter, in the August 30 issue, inquiring how the efficiency of his plant may be increased. I think that it would be poor policy to use compressed air in the place of steam for forcing the fires, during the summer at least, as it would require more steam to furnish the additional air than would be saved by cutting out the steam at the jets.

No doubt there is an excess of exhaust steam as it is. If it requires more steam to heat the buildings in the winter than the compressor furnishes by its exhaust, making it necessary to draw live steam from the boilers, then it would pay to use air in place of steam at the jets for forcing the fires.

If the turbines exhaust into a condenser and there is no possibility of needing more than the 350 cubic feet per minute for some time to come, then it would probably pay to install a motor-driven compressor. But the feed-water temperature would be lower unless there was sufficient exhaust steam from the feed pumps and pumps supplying condensing water to the turbine. Even if the turbines exhaust to the atmosphere it would probably pay to get rid of the large compressor and install a motor-driven one in its place.

In regard to the saving, there should be a substantial gain in replacing the steam-driven compressor with a motor-driven one, as it should be possible to purchase the small outfit for considerably less than the larger outfit should sell for if it has been kept in good condition. Then the water rate for the steam turbine should be reduced considerably. Also, there should be a saving in cylinder oil and packing over the steam-driven compressor.

The actual saving could not be computed unless the water rate for both the turbines and the steam-driven compressor

for different loads and the cost of coal per ton were known. If the shop or factory to which his plant furnishes power should require more air and electric current in a few years, it would be best to let the machines run as they are, because they will also need more heat if the plant is enlarged; then the additional exhaust steam will come in handy for heating in the winter.

As he has not stated whether there is enough exhaust steam for heating without taking live steam from the boilers and also has not said whether the turbines run condensing or not, it is a hard matter to make a positive answer as to whether it would pay to make the changes he proposes or not.

GEORGE DREYER.

Gilsonburg, O.

H. M. Lewis, in the August 30 issue, asks if it would not be cheaper to use compressed air for forced draft instead of steam, thereby increasing the load factor of his air compressor so as to enable it to operate at higher efficiency.

While it would, no doubt, raise the efficiency of the air compressor, it would be a bad proposition on the whole, as it would be cheaper to use the steam direct than to use the steam to compress air and then use the air for blowing the fires. Even if the efficiency of the combined engine and air compressor were 100 per cent. which is, of course, impossible, there would be nothing gained.

As regards running the air compressor with a motor, and obtaining current from the turbo-generator sets, the economy will depend on what drive his air compressor is equipped with at present. If it is driven by a wasteful engine, the turbine-generator-motor outfit might have the best of it, but if driven by a Corliss condensing engine in fair condition, it would appear that it would be another case of "going 'round Robin Hood's barn."

LEAL DAVIS.

San José, Cal.

Bearing Lubrication

Intelligent criticism is illuminating and to me always most welcome. I am not averse to being intelligently criticized providing it leads to the development of an idea or shows the falsity of a certain reasoning. With respect to Mr. Taylor's criticism in the August 30 issue of my article on "Oil Grooves and Bearing Lubrication" in the July 17 issue, I wish to say that although a hollow crank pin carrying a tube of oil or grease may be "an old idea," it is, nevertheless, a good one and along the line of progress.

With respect to the hole weakening the pin, I wish to say that it is the best modern practice to use hollow crank pins and shafts as such pins and shafts are stronger than the solid kind, which can be easily demonstrated all things else being equal.

With respect to "soft boxes," they have an inherent disadvantage which is obvious and I need not dwell further on this subject. Since the introduction of "hard boxes" or bearings at this plant, armature repairs have been successfully eliminated. Previous to their use an armature winder was constantly employed. In the near future there will be no more "soft boxes" in use. An engineer who has spent 20 or 30 years in one plant is, no doubt, familiar with the practice in that plant but there his experience ceases, and he is not in a position to know of the methods adopted elsewhere. His knowledge must necessarily be limited to that one plant.

With respect to any "misleading information" in my article, permit me to add that I will give a five-years' subscription to POWER to any person that the editor of POWER may designate if such person can point out any "misleading information" therein.

WILLIAM KAVANAGH.

New York City.

The Divided House

On the frontispage of POWER for August 30 some statements were made in regard to an assistant engineer which are worthy of much thought. It is surprising to find conditions similar to those described in so many power plants.

Having been in a position to see the operation of jealousy among power-house employees from all sides, I find that many engineers seem to forget that while the owner of the plant may pay them, and they are working for him, the same man hires the chief engineer to direct the work and looks to him, not the assistants, for proper operation and results.

If results are satisfactory, it will not concern the company how they are brought about, always providing that they are accomplished with safety and economy. Now, the man with a "grouch," who imagines that he is the hardest worked engineer in the country and is not appreciated, will often advance the statement that he will run his watch regardless of what the chief will say, for he claims that he is not working for the chief but for the company. A chief engineer hires a man to run a watch or to do other duty about the plant and he is called an assistant. This word means a man who assists, not one who interferes or prevents, and every man in this position who does anything else is not an assistant but a drawback; also every man who tries to defeat the purposes of a good chief engineer is not working for the interests of the company.

I know of an instance a few years ago where a man imagined himself in the position of the one mentioned in the editorial. He had started as fireman and worked up to first-assistant engineer. Having had but little previous experience he was in no position to judge of what he should have, and in reality he had the best position possible for an assistant in that plant. However, he tried to make those who were working with him discontented, and also tried to go around the chief and get relief from the management. This man had reached the point where no amount of reasoning or argument would convince him of the proper arrangement of things, and that he had many troubles on his watch which could be traced to his personal neglect. He sank to such a position that when he left there was no feeling of loss or of any vacancy to fill. He has not had as good a position since.

In another case, the assistant was continually complaining about adverse conditions, class of machinery, division of help, etc., and he made the statement that he was in supreme command over his watch for he was responsible for its operation to the company. Now, this idea, I hold, is entirely wrong, as any company which places a man in charge of its plant should hold him responsible and not the assistants, and he in turn should demand of his assistants such faithfulness and obedience to his wishes as will insure good service.

I also believe that if any engineer goes into a plant with the idea that he is there to aid the chief in every way possible, and to anticipate his wishes even if he does a little more than is expected, he will gain both in reputation and self-respect. If, however, he is working for a man who does not appreciate his efforts and who cannot give him encouragement to continue, then let him give his notice honorably and without any useless argument, for such things always take something from a man's character.

It should be the aim of all men to conduct themselves in such a way that their employers will look upon them as honorable men, even if there is a difference in ideas such that it is impossible for them to agree. Many a firm has kept a man whom they knew was reliable, truthful and temperate rather than change for one who might know more about the business but who was unknown to them personally. As Mr. Wakeman says in one of his books, the engineer should do all these things, for "his reputation for honorable dealing is at stake."

On the assistant's side, I would say that the chief should always give his orders directly to him, as any other arrangement will give the men under the assistant the idea that he has no authority. If the chief supports his assistants even as he is supported by the management, the house will be united.

These statements will prompt many to say that such conditions are impossible in all plants; but if jealousy, deceit and other undesirable traits are cut out, the

spirit of fair play and a desire to pull together substituted, the results will amply justify the change.

G. H. KIMBALL.

East Dedham, Mass.

What Causes the Scale?

I noticed in the August 30 issue the inquiry by Mr. Lynch who desires to obtain information as to how to prevent the formation of a black vulcanized rubber-like scale which accumulates on a steam-heated cast-iron form which he uses for bending, or shaping, certain kinds of wood, the wood being dipped in hot water before being used.

To illustrate how a black coating may be formed on heated iron under certain conditions, and by frequent application, or continuous action, be increased in thickness until it resembles a scale, a flat cooler in an artificial-ice plant will be taken as an example. The cooler, say, is of the atmospheric type.

The distilled water from the reboiler enters the cooler at a temperature of 180 degrees Fahrenheit, and the cooling water going over the cooler has a temperature of 70 degrees. If the cooler is allowed to operate without being blown out with steam, as they usually are for a certain purpose, and the cooling water has certain impurities in it, a green fungus will, after a few weeks, begin to make its appearance on some of the coils. It will extend about four pipes high from and including the bottom pipe, or to a point where the temperature of the descending cooling water has increased to such an extent by contact with the pipes near the bottom as to cause the formation of the growth.

This fungus is, I think, similar in nature to the substance which is giving Mr. Lynch trouble, only it is not "painted black" as yet. However, if the distilled water is cut off from the cooler and steam blown through, the steam-heated pipe causes the green matter to turn black, leaving a thin black coating on the pipes.

It occurred to me that Mr. Lynch might be using water containing impurities similar in nature to those in the water referred to. When the wood is dipped in the hot water the impurities contained in the thin layers of water which adhere to each section of wood may be thrown off by coming in contact with the heated form. If the form were operated at a lower temperature the scale might assume a different appearance; the high temperature naturally burns it black.

Layer after layer of impurities might be formed in this manner on the surface of the hot iron until a more or less thick scale resulted.

If Mr. Lynch is not using distilled water to dip the wood in, he might try boiling the water before using it.

W. W. HAILSTONE.

Youngstown, O.

Incompressibility of Water

Referring to the letter on "Incompressibility of Water," in the August 30 issue, I think Mr. Edgar has overlooked the fact that the pressure causing the decrease in volume of the water would also have a like effect on the iron. Although I can find no figures showing the relation between the volumes and pressures of metals in the solid state, most writers agree that solids are compressible, some even claiming that solids are about as compressible as water. This assumption is based on the fact that there is comparatively little difference between the volume of a body in the solid and in the liquid state. Therefore, it is reasonable to suppose that even to extreme limits of pressure, the ratio of the weights of equal volumes of iron and water will not differ much from that of 450:62.5, or 7.2, the specific gravity of cast iron. If the rate of change in volume is the same for both iron and water, the iron would sink until the bottom was reached, irrespective of the depth. Granting some difference in the compressibility in favor of the water, the distance at which a cubic foot of each would weigh the same as the iron would be a depth that would have no meaning so far as terrestrial distances are concerned.

W. G. HAWLEY.

Scranton, Penn.

Dissatisfaction and Jealousy

I have found that the first page of POWER is always full of truisms. On reading this page in the August 30 issue, I just closed the book and patted it on the back for I have been there.

In the beginning of my career I was an ordinary fireman, shoveling coal into furnace doors along with several negro stokers in a Southern power plant. The chief was a Massachusetts man, highly technical and a strict disciplinarian. Often, unknown to me, he stood behind me as I was firing, and when I had finished he would insist that I open the furnace door and pull out all lumps of coal larger than a man's fist. This was hot work and it seemed so unnecessary that it kept me mad all the time until it finally occurred to me that in order to avoid hauling out these big coals I had better not put them in. I adopted this plan only to find that the chief was just as ready to find fault with me for other things; he continually called my attention to the dirty floor, and insisted that I brush it up after each firing. In view of the fact that jobs were not plentiful and times were hard, I put up with this "foolishness," but in order to avoid continual use of the broom I learned to handle a scoop without spilling coal all over the floor. The rims of the steam gages also came in for criticism, and he discovered that the feed-water line running across the boiler fronts was brass covered with a thick coat of black paint. I then had to get busy and clean these pipes till they shone like new and keep them that way, in addition to doing my share of the firing.

I knew that I was being imposed upon as the darkeys had much easier times than I did, and received the same pay. However, in a year's time the size of the plant was doubled and the position of head fireman was created; I was selected to fill this position at slightly increased wages but elevation seemed only to aggravate things; the chief was more exacting than ever, nothing seemed to suit him, he found fault with nearly everything I did, and if I did an extraordinarily good job he never noticed it but always found something that was not up to his idea of perfection. It took me about two years to find out that the chief was the best friend I had and that instead of imposing upon me he was doing me a favor every time he criticized my work.

However, I had ambitions to leave the boiler room and try oiling on one of the three big cross-compound engines. The three oilers on these engines had the distinction of calling themselves assistant engineers, while I was only the head fireman. It grated on my nerves to see these oilers leave the plant as soon as the wheels stopped while I usually had to stay from a few minutes to a few hours on some dirty repair job. On Sundays I had to see that the boilers were properly washed and filled for service; and often I was called out of bed at midnight on Sunday nights to straighten out some trouble. All this was unpleasant, in view of the fact that the boys in the engine room were always telling me of the good times they had Saturday afternoons and Sundays.

After a while the chief went back to Massachusetts and a new man took his place. During the change I secured the coveted position in the engine room. Then I found that keeping the floors clean and the bright work polished and chasing around after stray drops of oil with a bunch of waste was a very monotonous procedure; the chief and the machinist did all the engine repairing and about all I was learning was the fact that the former chief was a better friend than I had realized, and I was very glad to go to another plant in the capacity of head fireman. There I made up my mind that the next step was not to be an oiler but to be the chief myself, and I straightway began a systematic course of study, took a personal interest in the plant, voluntarily doing many dirty and disagreeable jobs that the chief himself never knew of, and in a couple of years I became so confident of my ability that I ventured to take charge of a small plant as superintendent, having secured a good recommendation from my former employers. In a couple of years more, by continually keeping after technical as well as prac-

tical information, I was able to satisfactorily fill a position in a larger plant, and have continued to progress until now I have the satisfaction of being consulted in mechanical matters where decisions involve thousands of dollars.

I am now thankful for the strict discipline imposed on me by those who were my superiors in my early days. I am also thankful that times were so hard in those days that I could not afford to get mad and quit.

In nine cases out of ten the mean boss is the best one; he is usually intent only upon the efficiency of the plant, and the efficiency of the plant is directly proportional to the efficiency of the men who do the detail work. A good fireman does not always rise to highly responsible positions but he stands a much better chance than the indifferent man and, whatever the duties, it always pays to do them cheerfully and willingly and in the very best manner possible. If conditions arise that do not seem just, determine whether they are for the good of the plant; if there is anything in favor of the plant then rest assured that no matter how unjust they may appear personally, the plant comes first. If the boss really "has it in for a man" in a personal way, he usually leaves no room for doubt, but discharges him. It rarely occurs that a man in authority will continue to employ a man in whom he sees nothing to build on, except in the case of the lowest menial laborers whom we are not considering.

A. C. TERLENE.

Chattanooga, Tenn.

Piston Clearance

In the August 30 issue, P. S. Black gives his method of finding the piston clearance. This would not work with all engines, as there are a great many in which the piston rod is keyed to the crosshead instead of being attached by means of a screw and lock nut. The method I use and which will apply to any engine is to take out the crank-pin brasses, place the crank on the head-end center and push the crosshead back until the piston strikes the back head. Then, make a center-punch mark on the edge of the guide or frame to correspond with the corner of the crosshead or the center of the wristpin, whichever is most convenient. Do not use the crosshead shoe, however, as it may be moved later on, thereby throwing the marks out of the original position. Next, turn the engine over to the crank-end center, pull the crosshead up until the piston strikes the front head and make another point on the guide or frame to correspond with the point on the crosshead that was used before. Put the brasses back and turn the crank over to one center and measure the clearance on that end, which will be the distance from the mark on the crosshead to the mark on the guide. Then, turn the crank over to the other center and measure that end. With a rod keyed to the crosshead the clearance must be adjusted by putting in or taking out liners back of the brasses, depending upon the individual construction of each connecting rod. By using a square on the end of the wristpin or on some planed surface of the crosshead, the mark on the guide may be several inches from the one on the crosshead and still be exact so that the clearance can be measured as correctly in this way as in any other and the engineer will at all times have a permanent mark to check up by.

J. CASE.

Hyattsville, Md.

The Expansion Valve

To continue under this heading used in the August 30 issue of POWER, by J. J. Nash, considerably more information can be gleaned if we take the time to study the subject up. Many refrigerating engineers imagine that just as soon as the liquid ammonia passes the so-called expansion valve it immediately becomes a gas.

The conversion of water into steam through the transmission of heat into the water involves principles that are too generally understood to permit of discussion. If, however, we descend to degrees of temperature, which in everyday language imply cold, or lack of heat, the principle involved apparently assumes another aspect. Yet, there is no difference whatever in the causes which convert liquid anhydrous ammonia and water from the liquid into the gaseous state and no difference in the effect produced by each conversion.

Suppose that a thin stream of boiling water is continuously injected into a pipe coil which has been brought to a red heat. No one will question the fact that the injected water will immediately be converted into steam by contact with the heated pipe surface. Nor will one be surprised to learn that the pipe itself, beginning at the inlet end, will gradually cool down to the boiling temperature of the water. The water, still remaining at the boiling temperature, continues to flow on to where the pipe is still sufficiently hot to cause further evaporation of the water. The steam which is generated, in finding its way to the outlet of the pipe, though in intimate contact with the walls of the pipe, exerts but little cooling effect on them, owing to its limited capacity for absorbing heat or, in other words, its low specific heat.

When artificial refrigeration is considered, where the same process actually takes place though with different heat conditions, many engineers seem to be confused and take erroneous views of what is actually taking place. Such views are often held by men who have long been associated with this useful industry and who we would assume to be intimately acquainted with the process entrusted to their care and supervision.

No engineer has been known to call the valve through which he admits feed water to his boiler an expansion valve. Yet it bears the same relation to his boiler as the so called expansion valve bears to the system of freezing coils. In both cases its function is to regulate the feed. The simple experiment of evaporating a small quantity of liquid ammonia in a test bottle, where the conditions are more favorable for evaporation than those generally existing in a refrigerating plant, will convince the most skeptical that liquid ammonia does exist in the liquid state after passing the expansion valve. It should also convince him that the cooling effect is more intense on that portion of the bottle which is in direct contact with the liquid ammonia than it is on the portion of the bottle that surrounds the gas. This same process, which is so apparent in the bottle, takes place in the dark recesses of every freezing coil.

WILLIAM G. WALTERS.

Stratford, Ont., Canada.

The Canton Boiler Explosion

The verdict of Coroner Harry A. March, as related in the editorial in the August 30 issue on the Canton explosion, seems to have caused an explosion of criticism. It is told that while Abraham Lincoln was engaged as a lawyer, he listened to a harangue by his opponent and after he had finished, Lincoln arose and said that his opponent reminded him of a Mississippi River boat that had a four-foot boiler and a six-foot whistle; when the whistle blew, all of the machinery was compelled to come to a standstill; similarly when his opponent began to talk his mental machinery for reasoning apparently ceased to act. It is my opinion that Mr. Harrington, who criticizes Mr. Allen in his letter on page 1698 of the September 20 issue, is in the same boat with Mr. Lincoln's opponent.

Mr. Harrington's criticism certainly must have been hastily prepared. He endeavors to make it appear that Mr. Allen advanced the theory that the explosion might have been caused by turning cold water into the boiler while it was red hot, when the most cursory examination of the evidence will show that the local boilermaker, Mr. Wheelan, was the one responsible for this theory, and not Mr. Allen. Mr. Harrington does not believe that waterhammer may be caused by turning steam into a boiler in which the pressure is lower than in the steam main. He may be interested to know that the production of waterhammer is far more certain in this manner than when the pressures are reversed. Mr. Harrington, although in the State of Massa-

chusetts, and presumably holding an engineer's license to operate boilers in that State, seems to be badly mixed regarding the amount of pressure that would have been allowed on the Canton boiler should it have been located in the State of Massachusetts. The Massachusetts rules specify a factor of safety of five and three-quarters for lap-seam boilers over fifteen years old, and if the rivets in the Canton boiler were steel (which was doubtless the case), the Massachusetts rules would have allowed a pressure of 76 pounds, if the boiler was of the construction represented in the description in POWER of May 31. This pressure is considerably above the "less than sixty pounds" given by Mr. Harrington. Even if the rivets had been iron, the allowable pressure would have been 68 pounds under the Massachusetts rules.

This boiler was operating on a factor of safety of about 4.4 at 100 pounds pressure, which can certainly not be severely criticized, for it is doubtless considerably in excess of the average factor of safety on which boilers are operated throughout the United States.

Francis B. Allen has long been engaged in the boiler-insurance field, and probably has investigated as many, if not more, boiler explosions than anyone else in the country, and under the circumstance it does not seem right to pass by unnoticed a criticism of his opinion based on such a lack of facts as is Mr. Harrington's.

I think that Coroner March deserves a great amount of praise for the good sense displayed in arriving at his verdict. Acknowledging his own lack of experience along the lines necessary to reach an intelligent verdict, he accepted the opinions of persons expert in the investigation of such accidents, rather than endeavor to give snap judgment on the testimony offered.

S. F. JETER.

New Haven, Conn.

Advantages of License Laws

Yes, it is much cheaper to pay top wages to a first-class mechanic who can and will keep the wheels moving, than to intrust to a poor one several thousands of dollars worth of equipment simply to effect a saving of two or more dollars per day. The expense of one preventable shutdown might easily offset the difference in wages for an entire year.

In a no-license State how shall the employer decide upon the merit of an applicant who is unknown to him unless he judge by letters of recommendation which too often are worthless, as I have found by experience. If Mr. Incompetent can create a sufficiently favorable impression, he may be hired if a man is needed. Many engineers of poor ability possess a kind of cleverness which may appear like real wisdom to a prospective employer who happens to know nothing of the specific requirements of the position. Since a high salary is not always then a guaranty of worth, bearing in mind that the employer's point of view is that of the uninformed, is it surprising that the small owner prefers to hire "Mike," who is "handy" and who can be had for two dollars per day? He will say:

"Mike is handy; if anything breaks he can always patch it up somehow and manage to get along." But he spoils this in the next breath, when he says:

"Mike is always busy—he can always find something to do." This "being busy" is a point that wins much favor with this class of employer. He does not know that the engineer who has time to seat himself and talk to a visitor or to show him about the plant may nevertheless have his senses on the alert; that a proper degree of watchfulness and foresight will suggest the use of hammer and wrench *before* trouble grows serious enough to cause a shutdown, thereby preventing nine-tenths of the so-called accidents that would befall "Old Mike" in like circumstances. The man in the overalls has nothing to lose—whatever may happen to the plant in his care, he can collect his wages—the owner is responsible, and in case of accident he has no redress.

As long as the law will permit incompetent men to remain in positions where ignorance may jeopardize the lives of others, there will be certain people willing to hire them.

Recently one or two engineers have expressed the opinion in POWER that license laws would have but little beneficial influence. They neglected to give any reason in support of this view, however, and should like to call their attention to the fact that with the enforcement of a proper law, an immense number of operating misfits would at once be obliged to leave the field clear for those who by virtue of a superior intelligence and ambition already possess the necessary qualifications.

There doubtless are state license and inspection laws that are excellent. Nevertheless it would seem that a national law would be highly desirable on account of the uniformity that would result and for the reason that the United States Government seldom does anything by halves.

Not long since, a firebox boiler was to be replaced by a new and larger one and the operator was asked for his opinion of the return tubular type. He had no idea what "return tubular" meant, but he was anxious to favor any possible preference the owner might have and so, to avoid committing himself irrevocably, he ventured:

"Yes, I've seen them there; but somehow—I don't care much for them." When the new boiler and other new equipment was ready for operation, this man was retained to take charge of it on the ground that he should have a trial because he had never had any serious trouble with the old outfit.

This plant was merely a side issue to the owner's other business, and in common with many successful small capitalists, he fully believed the care of such to be a trivial thing. This idea was gained by occasional visits to the power house and conversation with those of a smaller mental caliber than himself. For instance, a sudden repair job confronted the engine runner. The "Old Man" being present, was told that the defective part must be sent to the shop. On the principle that "two heads are better than one," he suggested an expedient that had not occurred to his mechanic, and time and expense were saved. After a few such occurrences the owner began to think that the engineering profession as it affected him, should easily be comprehended by a two-dollar-per-day man, and in proof he would cite his own genius in solving an unfamiliar question. Thus he surrounded himself with a wall of egotism which seemed proof against all argument.

Take again the employer who believes, on principle, in having the best of everything—equipment, supplies and operatives, and is willing to pay the price; here he may be between the devil and the deep sea. Please state, you non-license men, how you in his place, would judge the fitness of applicants without running the risk of placing your plant in the hands of one worthless man after another.

Let us hire good men, but let the Government weed out the ineligibles for the safety of the public.

G. W. JOHNSON.

Escanaba, Mich.

Pumping Layout

I read with interest the discussion of a pumping layout in the September 6 issue. Truman D. Hayes is decidedly wrong in his statements regarding the Pohlé air lift. He states that the water pumped by the Pohlé system must be allowed time to free the air.

As the mingled air and water in the pipe rises to the surface, the pressure gradually reduces until at the pipe outlet it is only that due to the atmosphere, provided the discharge is open to the atmosphere. As the pressure decreases, all of the air separates from the water except that which is naturally held by the water in solution and no amount of standing would serve to liberate any of the water so retained.

Mr. Monthau's discussion, in the same issue, is more nearly correct.

WILLIAM G. VEDDER.

Fort Logan, Colo.

The Largest Boilers in Existence

Editorial Correspondence

At the Delray station of the Detroit Edison company it is planned to operate each 14,000-kilowatt turbine with steam supplied by two specially designed Stirling boilers. Two are already installed.

Lately there have been some interesting developments in the line of large-capacity boiler units at the Delray station of the Detroit Edison Company. These developments have taken place in the new addition to the original plant known as No. 2 station, which, when completed, will consist of two 14,000-kilowatt Curtis turbo-units and six Stirling boilers of large capacity; the plan being to have two boilers serve one turbine on the unit system, with one boiler for each unit always in reserve. There are two of these boilers already in operation, one equipped with Roney stokers and the other with Taylor underfeed stokers; a description of the former, however, will apply essentially to the latter.

The boiler, as shown in the sketch, is double ended with the elements facing one another and the stokers under each end. There are three steam and two mud drums, each 27 feet 9 inches in length, the central one being 54 inches in diameter and the others 48 inches. They are made of 1⅛-inch steel plates having a tensile strength of 60,000 pounds per square inch and are connected by banks of curved tubes as in the regular Stirling type. The tubes are of the standard size —4 inches in diameter—and if placed end to end would reach a distance of about 4½ miles.

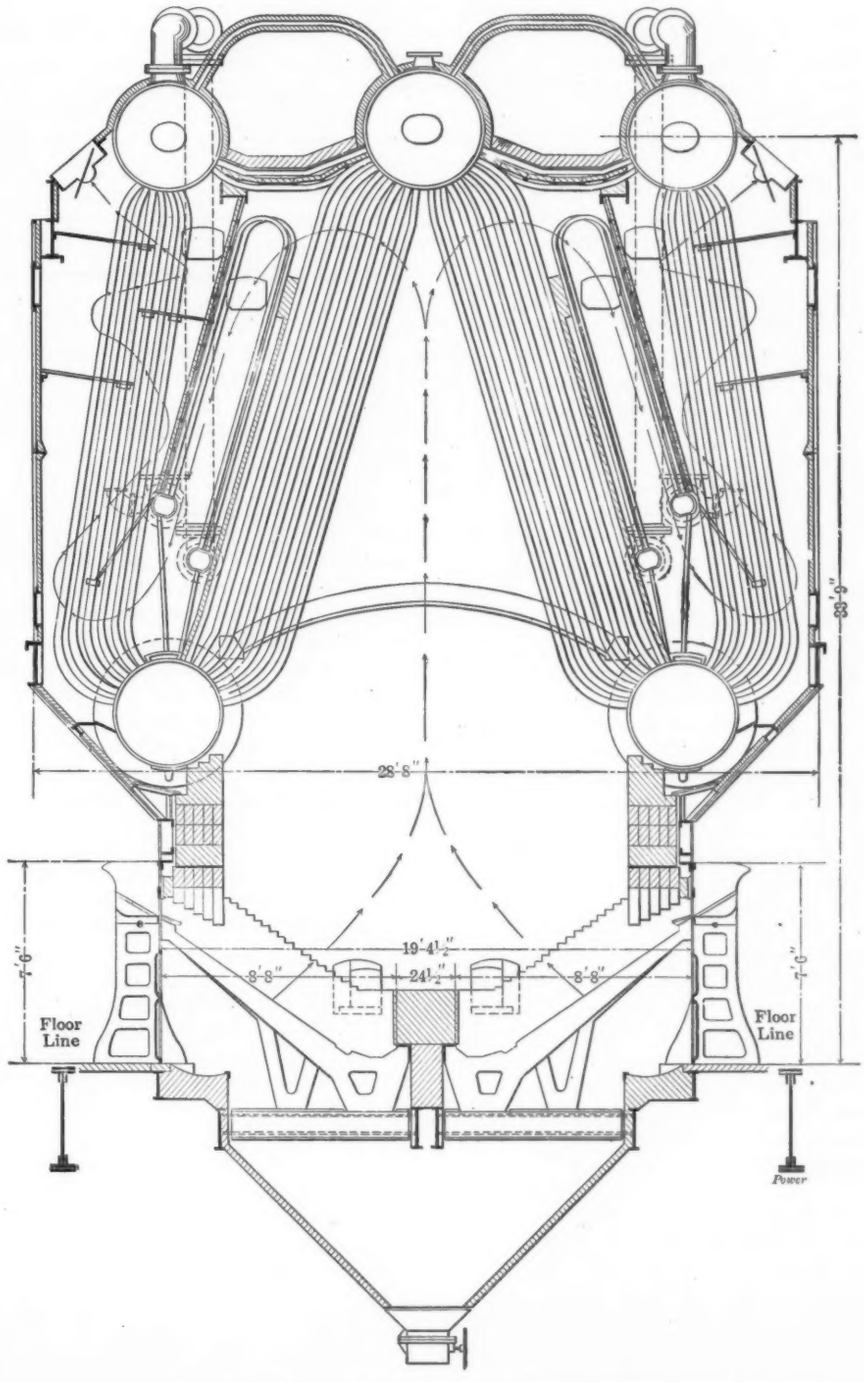
Steam is taken from the two side drums through 5-inch Hopkins-Ferranti straightway stop valves having constricted areas measuring 2½ inches in diameter. It then passes to standard Babcock & Wilcox superheaters, one of which is installed in each end of the boiler, thence out to a Y-connection and into the line through a 10-inch Hopkins-Ferranti motor-operated valve with a 5-inch outlet.

The boiler is equipped with four Roney stokers, each having a grate surface of 120 square feet, making a total of 480 square feet with a ratio of heating to grate surface of 48 to 1. The normal working pressure is 200 pounds with 175 to 225 degrees of superheat.

No official figures are available regarding the performance of this boiler, as there has not been time enough to make careful tests. The largest load carried on the boiler to date is stated to be 9000 kilowatts on the main turbine in addition to about 300 kilowatts on the auxiliaries, making a total approximate load on the boiler of 9300 kilowatts or 12,400 horsepower. Allowing 14 pounds of steam per kilowatt-hour for the main unit and auxiliaries combined gives 130,000 pounds of water evaporated per hour at this load, which, divided by 23,040, represents 5.64 pounds of water evaporated per square foot of heating surface.

When steaming at the maximum capacity, a kilowatt is generated on 2.48 square feet of heating surface. The circulation is toward the central drum, the water level being maintained much higher here than in the side drums. In fact, the latter act as steam drums, very little, if any, water remaining in them when under heavy load.

The feed water is introduced into the side drums, flowing downward into the second bank of tubes. A high efficiency is expected owing to minimizing the radiation and other losses per unit output.



STIRLING BOILER EQUIPPED WITH RONEY STOKERS

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Heat Transference

I have a feed-water heater arranged so that the steam and the water to be heated enter at the same end, that is, the hottest steam and the coldest water enter together. Now, if I should reverse the flow of the water, and have it enter the opposite end of the heater so it would leave the end where the steam is hottest, will it make any difference in its temperature?

W. H. R.

The transfer of heat from the steam to the water is proportional to the difference in temperatures, and where the hottest steam comes in contact with the hottest water the average temperature difference is greater than where the order is reversed and the coldest steam comes in contact with the hottest water. Therefore you would under ordinary conditions get hotter water with the contraflow.

Pressure of Superheated Steam

A boiler contains water under 200 pounds pressure and saturated steam at a temperature of approximately 387 degrees Fahrenheit. Superheat this steam 100 degrees, and the temperature would then be 487 degrees Fahrenheit. What would be its pressure?

H. D. Y.

Superheating does not change the pressure. By definition superheated steam has a temperature higher than that due to its pressure. If it is superheated 100 degrees it will have the original pressure but will have a temperature 100 degrees higher than that due to its pressure, whatever that may be. Steam at 200 pounds pressure superheated 100 degrees will have a temperature of approximately 487 degrees and still remain at 200 pounds pressure.

Spring Piston Rings

In getting new piston rings for a 13x12-inch high-speed automatic engine, what is the correct method with regards to taking the dimensions? Should rings be made thicker on one side than the other, or a uniform thickness all round? In taking out the old rings I find them to be ⅜ inch on the bottom, tapering away to ¼ inch on the top where rings are split.

S. P. R.

Spring rings should be made ¼ inch larger than the cylinder for each foot in diameter and enough cut out so that the ring will just fit the cylinder without coming together at the split. There is a variety of opinion among engineers and designers as to whether spring piston rings should have uniform thickness or otherwise. It is really a matter of no importance as both kinds are used successfully. Unless protected by a keeper which will prevent the leaking of steam past the ring through the split, the split should always be kept at the bottom and not at the top of the cylinder.

Contents of Cylindrical Tanks

Please let me know how to figure the following: A horizontal tank 10 feet in diameter by 20 feet long contains 18 inches of liquid. How many gallons are there in it?

H. B. I.

A method of finding the amount of liquid in partially filled horizontal cylindrical tanks was given in the issue of August 9. The cross-sectional area of the liquid in the example given is 7.38 square feet, which, multiplied by 20, the length of the tank, gives 147.6 cubic feet of liquid. As there are 7.48 gallons in one cubic foot, there are

$$7.48 \times 147.6 = 1104.05$$

gallons of liquid in the tank.

Horsepower of Falling Water

A stream of water 4 feet wide and 18 inches deep runs over a dam and falls 14 feet. How much power can I get out of it?

M. G. F.

A stream of water 4 feet wide by 18 inches deep running over a dam would discharge 24 cubic feet per second; and the energy would be the weight of the water multiplied by the hight from which it falls,

$$62.3 \times 24 \times 14 = 20{,}932.8$$

foot-pounds per second. As 550 foot-pounds per second is the equivalent of a horsepower, the stream would deliver

$$20{,}932.8 \div 550 = 38$$

horsepower, 70 per cent. of which might possibly be realized, giving

$$38 \times 0.70 = 26.60$$

actual horsepower.

Required Pressure for Operating Pump

I wish to apply 200 pounds hydrostatic pressure per square inch to a boiler with a 6 and 4 by 6-inch steam pump. The suction is attached to the city water main in which there is a pressure of 35 pounds per square inch. What steam pressure will be required to operate the pump?

M. P. M.

The area of the 4-inch water piston is 12.56 square inches, on one side of which is the pressure of the water going to the boiler and on the other that of the city water. The difference between these pressures which must be overcome by the steam pressure against the steam piston is 165 pounds per square inch. The total pressure to be overcome is

$$165 \times 12.56 = 2072.4$$

pounds.

The 6-inch steam piston has an area of 28.27 square inches and to balance the pressure of 2072.4 pounds on a water piston, it will require

$$2072.4 \div 2827 = 73.3$$

pounds per square inch steam pressure.

How much higher the steam pressure will have to be to overcome the friction of the pump and the water will depend on the circumstances in the case and can only be determined by experiment. It is probable that 100 pounds steam pressure will do the work.

Keeping a Boiler Dry

Keeping a Boiler Dry

What means should be used to keep the inside of a boiler dry while out of service?

B. D. K.

Several methods are employed. Some engineers make use of the natural circulation of the air through the upper and lower manholes which are left open for this purpose. Others place pans filled with quicklime inside and close all openings.

Pressure Required to Turn Crank

With the same load on the engine, will the same steam pressure tend to turn the crank faster when the crank pin is on the upper quarter than when on the lower one?

M. C. R.

When pressure is applied to the crank pin the tendency to turn the shaft is the same whether the pin is above or below the center, and is proportional to the pressure applied, and there is no difference in the power delivered.

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Power and The Engineer

Editorial

Pay Firemen on B.t.u. Basis

Welfare work is being undertaken by great corporations on an extensive scale with the realization that any outlay expended in this direction will be well spent in quality and quantity of work returned by those who benefit by the system instituted. This idea is recognized in the power plant as well as in the various branches of industry. There has been scarcely a plant erected in the last few years in which some provision has not been made for the comfort of the operatives. Anything which tends to create a personal interest in the work is of value in increasing the efficiency of an employee. There is a great difference between the worker doing merely what he is paid to do and the interested employee attending to those endless and countless little details for the welfare of the business.

In the case of the fireman this is especially true. By many managers he is considered the most important factor in the operation of the steam plant. He shovels coal and coal means dollars, which, if saved, will mean increased dividends to the company.

In this connection, therefore, it is of special interest to notice the results of a bonus system for firemen employed in a certain plant, as brought out in the late meeting of the Central States Water Works Association. Here, on a daily fuel consumption of from twelve to sixteen tons, there was a net saving, after paying all bonuses to firemen, of from six to eight dollars a day, merely through a system which created an interest in the work being done.

If it is considered good practice to buy coal on the B.t.u. basis, why should it not be equally advantageous to pay a fireman according to the number of B.t.u. that he is able to transfer into useful work? The fireman is given a certain amount of coal containing a known number of heat units, and the measure of his efficiency and consequently his rate of pay should be the number of heat units he is able to transfer to the water in the boiler. With such a system in vogue, it can be taken for granted that the results will be as favorable as the fireman can make them with the class of installation and apparatus with which he has to deal—and he will have a more intelligent interest in and appreciation of that apparatus.

Boiler Feeding by Centrifugal Pumps

In Europe the practice of feeding steam boilers by means of centrifugal pumps, either turbine- or motor-driven, is quite common, but in this country it is the exception. Just why designers of power plants on this side of the water should lag in this respect is not clear, for there does not seem to be any good reason why boiler feeding by means of the centrifugal pump should not become common practice.

Perhaps the claim that a small steam turbine will consume more steam than a steam engine of the same output may have something to do in influencing engineers against taking up this system of boiler feeding, and not knowing exactly what the performance will be they hesitate to take a step into the dark. A non-condensing steam turbine uses less steam by far than a reciprocating steam pump.

Excessive steam consumption in boiler-feeding apparatus in condensing plants need not be considered as a serious drawback, because the steam passing through such units is frequently not enough to heat the feed water to a proper temperature. In winter, if the plant furnishes exhaust steam for heating purposes, and many of them do, the auxiliary exhaust steam is often insufficient and live steam is used from necessity.

It will be conceded by all that the turbine-driven centrifugal pump occupies but little space and requires scarcely any floor room and foundation other than enough to bring it to a convenient level above the floor. The advantages of such a unit where the available room is restricted is quite apparent.

For convenience of operation the turbine-driven centrifugal pump has no equal. There is no noise in its operation and it requires practically no attention after being started. The first cost is greater than any other type of steam-driven pump, but the upkeep should amount to very little and the bother of renewing packing is practically eliminated.

Cleanliness is another feature favoring this type of boiler feeder. Being compact it is easily kept clean, and to avoid leakage of water on the pump-room floor the drippings from the stuffing box may be easily caught and piped to a suitable drain.

The ordinary boiler feeder is never run at a constant speed. In small plants the

water tender is almost constantly turning the throttle valve of the pump either open or shut. If a feed-water regulator is used, as is common in large plants, the speed of the pump is automatically controlled, but when the speed of the pump is reduced the amount of steam entering the feed-water heater is also cut down, and the water enters the boiler at a lower temperature.

In the case of a centrifugal boiler feeder the speed remains constant regardless as to whether one boiler is being fed or a dozen. The steam consumption may vary somewhat, but under ordinary conditions it will hold close to an average, and if a change does take place it will be so graded as to have no sudden effect upon the temperature of the feed water entering the boiler.

The pressure on the water main is constant (if the pump runs at constant speed) and cannot be increased by shutting off feed valves. Even if a stop valve on the main were closed the pressure in it would not go up, as the pump impeller would simply churn the water in the case. There is, therefore, no danger to the heater tubes, etc., nor to the piping. The flow of water is free and continuous and there is no clicking and slamming of check valves.

It is possible that the turbine-driven centrifugal pump for boiler feeding may have objectionable features with which the majority of engineers are not familiar, but if there are good reasons why such a pump cannot be used to advantage in feeding boilers, the readers of POWER should know about them. So bring out your paper and pencil and get busy.

Boilers of Large Capacity

In engineering circles it is now being recognized that the greatest economy is attained by working the heating surfaces to their limit, and that there is less loss with an intense fire and rapid circulation of the gases than with a large, slow fire, allowing gases to escape up the stack unburned. This practice of forcing boilers has been brought about by the demand for greater power. In many of our larger plants the distribution and class of service have been so carefully thought out that an almost constant load factor is attained. Where such conditions exist it is well to concentrate the load on as few boilers as possible and force them, thus minimizing the losses.

Unfortunately with the increasing demand for power and the consequent introduction of large turbine units, boiler practice has not kept pace as far as the capacity of the individual unit is concerned. But now comes the announcement of a bold step, page 1831, in this direction at the Delray station of the Detroit Edison Company. Here it is planned to have each fourteen thousand-kilowatt turbine served by two Stirling boilers of a size heretofore never attempted. Two of these boilers have been erected and put into service; and from a reliable souce we learn that one of these has developed as high as twelve thousand four hundred horsepower at the engine, although nominally rated at only about twenty-three hundred boiler horsepower. The public awaits with keen anticipation the publication of the official test figures showing the quality of steam produced, the economic evaporation and the coal burned per square foot of grate surface. The success or failure of this installation will have a potent influence upon future boiler practice.

Raising the Standard

Not the least encouraging feature of the evidence that the Institute of Operating Engineers will be successful in its aims is the attitude of the employers of operating skill toward the organization wherever they have been approached. It is beginning to be realized that the engineer holds an important position in production and transportation, as well as in all allied industries, and with this realization comes also the knowledge that the men who operate engines and power machinery must possess both skill and character.

As training in the vocation and cultivating desirable traits of character with habits of industry and sobriety is one of the principles upon which the organization is founded, it meets with a hearty welcome. It will be a powerful element in the "uplift" work, which in almost numberless forms is going on everywhere, for it will not only evolve better men but will force better working conditions just as fast as it is seen that only the best of conditions will attract the best men.

Besides the technical and mechanical qualifications some general culture will be expected from all who become members. It frequently happens that the employee who can, when called upon, give intelligent and concise replies to questions sometimes only remotely related to his work, is the one who is selected for a particular duty requiring tact and general information as much as the purely technical knowledge of the work. It is one of the aims of the Institute to aid men to acquire a more general education.

It is related that a peasant's excuse or reason for keeping the pig in the house was because the house had all the conveniences that a pig needed. In the growing industrial system employers of skill will not furnish houses for pigs, nor will pigs have any place in the equipment.

It is the aim of the Institute to evolve a class of workers to whom the employer will offer only the best conditions obtainable. There may always be inferior and ignorant workers and there may also always be employers who value a worker in direct proportion to the grime and gurry on hands, face and raiment, but the Institute aims to eliminate both. One class will not be in the membership and the other will not be numbered with the patrons. It is an attempt to give the calling of engine and machinery operation and management the place in modern industry which so manifestly belongs to it, but, which, through several causes, has not come into its own.

Carroll Balks at an Examination of His Carbonic Acid Gas Engine

We announced in our issue of July 12 that John Carroll, of carbonic-acid gas-engine fame, had been arrested by the United States Post Office authorities at Boston, on a charge of fraudulent use of the mails. It was decided to have his invention tested by experts appointed by the Government, in order to determine if there were any merit in it, or if it were a fraud. Arrangements were made by the Post Office department at Boston, in conference with Mr. Carroll, to have Professors Berry, Riley and Rowe, the first two from the Massachusetts Institute of Technology, and the latter from Harvard, examine the engine on May 27. When the time arrived, Mr. Carroll claimed to be sick and refused to allow an examination to be made. It was then decided to postpone the examination to a date to be named later, but Mr. Carroll later refused to allow an examination to be made at all, and was then arrested. He was forced by certain of his backers to ask for an examination, and accordingly, on July 21, E. G. Bailey, M. E., of the Fuel Testing Company, of Boston, Professors Berry and Taft, of the Massachusetts Institute of Technology, and Professor Rowe, of Harvard, made an examination of the engine.

The holes in the regenerating tank (evidently those referred to in our description of the engine on page 937 of the May 24 issue) appeared to be plugged up; the engine would not run. Carroll asked for time to repair it. This was granted and another test arranged for August 6. At this test Carroll had secured but a small amount of carbonic-acid gas and a test could not be made. Another date was set for August 16, at which time the holes spoken of were found to be open. The engine ran with a pressure apparently equal in both tanks, but it was apparent that he was exhausting from the charging tank and the outer tank of the regenerating tank into an inner tank and thence through the holes into the air. Soon after this Carroll was surrendered by his bondsmen and has since been in jail. On Tuesday, September 27, he was indicted by the Federal Grand Jury. He is also still under indictment in Philadelphia, where the original exploitation, exposed by POWER in the fall of 1907, was carried on.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

Rotary House Pump

A new type of house-service pump, shown in Fig. 1, has recently been introduced into this country from Germany, where it has been operating successfully for several years. The American rights, including those for the controlling apparatus, have been secured by the Rotary House Pump Company, 103 Park avenue, New York City.

This system of water supply consists

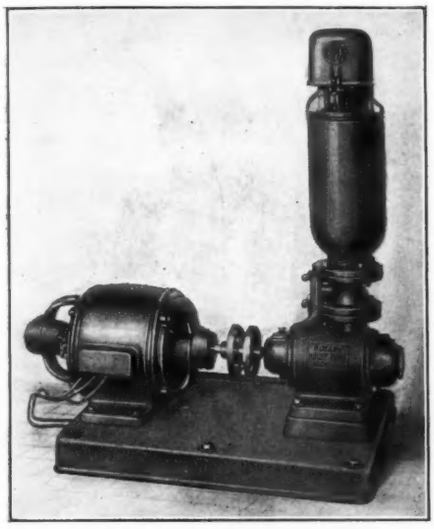


FIG. 1. ROTARY HOUSE PUMP COUPLED TO MOTOR

of a Pittler pump direct coupled to an electric motor and a bedplate on which the pump and motor are mounted. Air is compressed in the top of the air chamber to a predetermined pressure, when it actuates a small diaphragm throwing out an automatic switch and cutting out the motor. When the pressure falls in the air chamber, due to water being drawn from the system, the reverse action occurs, the diaphragm being actuated by a spring. The system is automatic, the motor driving the pump only when water is being drawn from the system. The water is never lifted higher than the faucet or outlet being used.

The pump consists of a rotating bronze cylinder secured to a shaft and revolving between two end cams having parallel curved faces. The cylinder has rectangular slots in its surfaces which are machined parallel to the axis and contain sliding vanes. The whole is inclosed in a casing containing ports connecting the pumping chambers with outlet and inlet pipes. The two end faces of the rotating cylinder are plain surfaces, perpendicular to the shaft. The end cams have special surfaces, which form a series of working chambers around the shaft at either end of the rotating cylinder, and the ends of the vanes enter these working chambers by reason of the cam surface at the opposite end. There is a port in the casing over the first part of each working chamber connected to the inlet.

Fig. 2 shows a diagrammatic representation of the pump projected on a plane. The vanes sliding between the two parallel and curved guiding pieces pass once the suction opening and once the discharge opening in the casing with each full rotation of the shaft. In position *I*, at the left, the upper edge of the sliding vane is just entering the suction chamber which is open to the suction port. When moving toward the right from *I* to *II* under the suction port the vane is surrounded by inflowing water with a balance of pressure on either side, the vane sliding endwise out of the rotating cylinder. At the moment this sliding vane reaches the end of the suction chamber (position *II*) the preceding vane passes the beginning of the discharge port, so that the first vane in moving toward the right forces the water in front of it into the discharge port. In moving from position *II* to *III* the vane forces the water ahead of it by its piston action to the discharge port, at the same time sucking water with the opposite side. During this period the vane does not slide in the rotating cylinder so there is but slight loss by friction. From position *III* to *IV* the vane slides under the outlet with balanced pressures on either side, the sliding of the vane against the curve taking place without any great resistance. From the position *IV* to *I* the vane is at rest, remaining entirely in the rotating cylinder, its purpose being to tighten the suction chamber against the pressure chamber.

On the other side of the drum the same action takes place, only at a difference of 180 degrees. Each vane with each full rotation of the drum therefore sucks and forces a quantity of water which has twice the volume of the space inclosed between the two sliding vanes in positions *II* and *III*. At the end of the suction and forcing periods of one sliding vane, this one is immediately replaced by the full side of another one, and therefore an absolutely equal quantity of water is being constantly pumped or drawn in for every position of the shaft if it is rotating uniformly.

Nearly all water contains grit or solid matters of some kind, which causes a certain amount of wear on the ends of the vanes butting against the cam heads. For this reason the pump is constructed with vanes divided through the center. Pressure is introduced between the two halves by leading a small channel from the discharge to a groove, which entirely surrounds the rotating cylinder. By this means, the vanes are kept always in contact with the cams at either end and the wear on the ends of the vanes is automatically taken up, maintaining the efficiency of the pump. The rotating cylinder being of bronze, and the vanes of suitable material, the sticking or rusting together of the moving parts is entirely eliminated, it is claimed. The balancing effect of the pressures on the sliding vanes reduces ordinary wear to a mini-

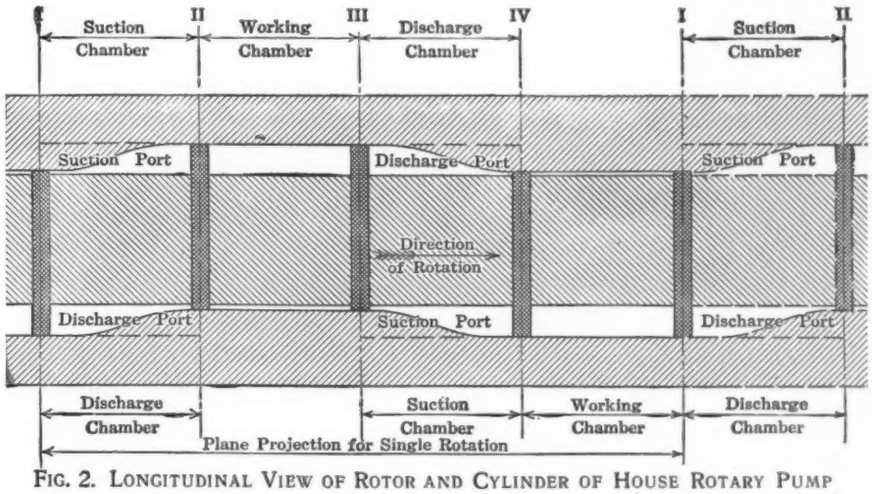


FIG. 2. LONGITUDINAL VIEW OF ROTOR AND CYLINDER OF HOUSE ROTARY PUMP

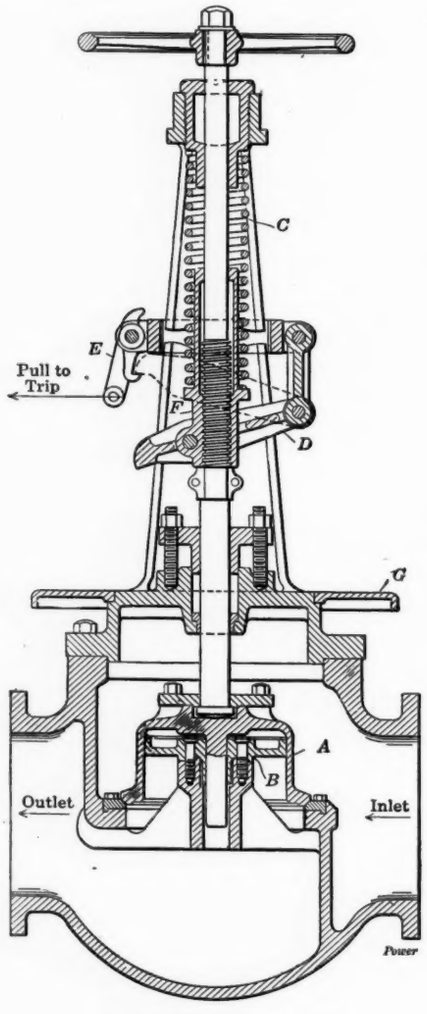
mum. With this split-vane construction, the pump maintains its volumeter efficiency even when pumping mud and sand, it is said.

This pump is applicable to all classes of pumping work, combining the advantages of rotary action, as with turbines or centrifugal pumps, with a positive delivery.

The only lubrication necessary is provided by ring oilers on the shaft, which are fed by the oil reservoirs at either end of the pump.

Low Pressure Turbine Trip and Throttle Valve

This valve is used as a combined throttle and trip valve for low-pressure turbines. The essential features are a means of throttling by a handwheel and screw spindle combined with the automatic tripping and closing of the valve by the turbine governor.



TRIP THROTTLE VALVE

The valve has a solid bell-shaped disk *A*, which forms a dashpot by moving over a fixed piston *B*. This prevents the disk from ramming the seat when it is tripped.

The closing medium is a spring *C* in the yoke, which is sufficiently strong to close the valve when it is tripped and overcome the friction and light internal pressure on the spindle.

The pressure always enters the body of the valve above the seat in the direction of the arrow. When the valve is closed and the lever *D* is engaged in the hook latch *E*, the valve may be operated as a stop or throttle valve by the handwheel. The hook latch *E* is connected by a rod to the automatic tripping arrangement of the turbine governor and when this hook latch is tripped, the screw trunnion *E*, which is carried by the lever *D*, is forced down by the spring, carrying with it the screw spindle of the handwheel and disk, thereby closing the valve. To reset the trip hook, the handwheel is turned in the direction of closing or "clockwise;" this raises the trunnion and lever and compresses the spring without disturbing the disk of the valve on its seat. After the lever is engaged in the trip latch, the valve may be opened or closed by the handwheel as at the start.

The plate *G* is intended as a finish to the asbestos or other material with which the body may be covered.

This valve is manufactured by the Schütte & Koerting Company, Tompson and Twelfth streets, Philadelphia, Penn.

New High Duty Self Cleaning Stoker

The Under-Feed Stoker Company of America, Marquette building, Chicago, Ill., is now making a new self-cleaning stoker designed to be used in plants where the greatest possible horsepower is desired in the least possible space. This stoker is not intended to replace the standard Jones stoker, but has been designed to meet the increasing demands for a greater fuel-burning capacity.

The operation of the new stoker is the same as that of the standard design, the proportionment and regulation of fuel and air supply by means of steam pressure being retained. The parts of the new stoker outside of the furnace proper are counterparts of the standard stoker. Inside of the furnace the essential points of difference may be noted as follows:

The depth of the retort at its forward end is over double the depth of the retort used with the standard stoker, the depth gradually decreasing toward the rear until at its extreme rear the depth is practically the same.

The self-cleaning mechanism is operated by an auxiliary cylinder, which is located under the floor line. The location of this cylinder, however, is not fixed

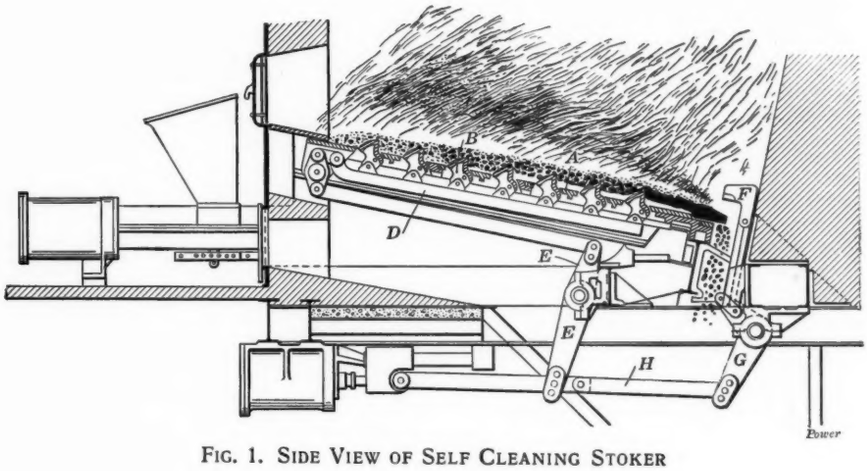


FIG. 1. SIDE VIEW OF SELF CLEANING STOKER

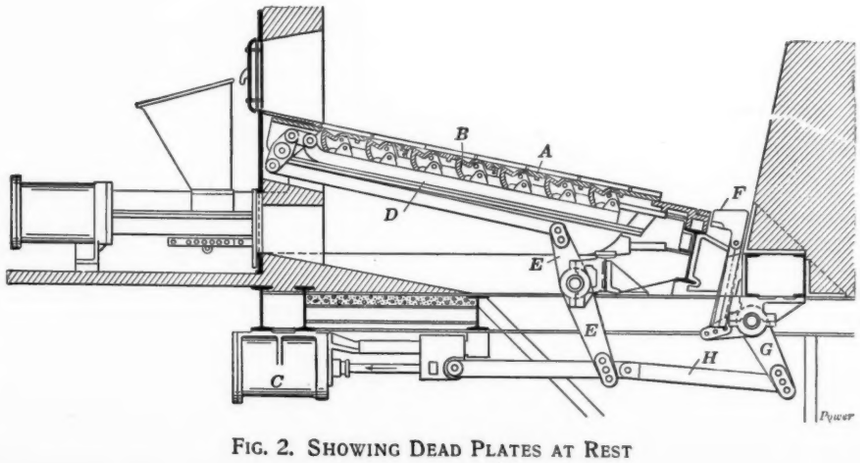


FIG. 2. SHOWING DEAD PLATES AT REST

and it may be located on the floor line at any accessible point.

Sectional dead plates are used, each section locking into its mate. These dead plates have a longitudinal movement varying from 2 to 6 inches or more, as desired. They contain rectangular openings for receiving the dogs *B*, Figs. 1 and 2, which are located at intervals of approximately 9 inches lengthwise of the plates.

Beneath each dead plate and actuated

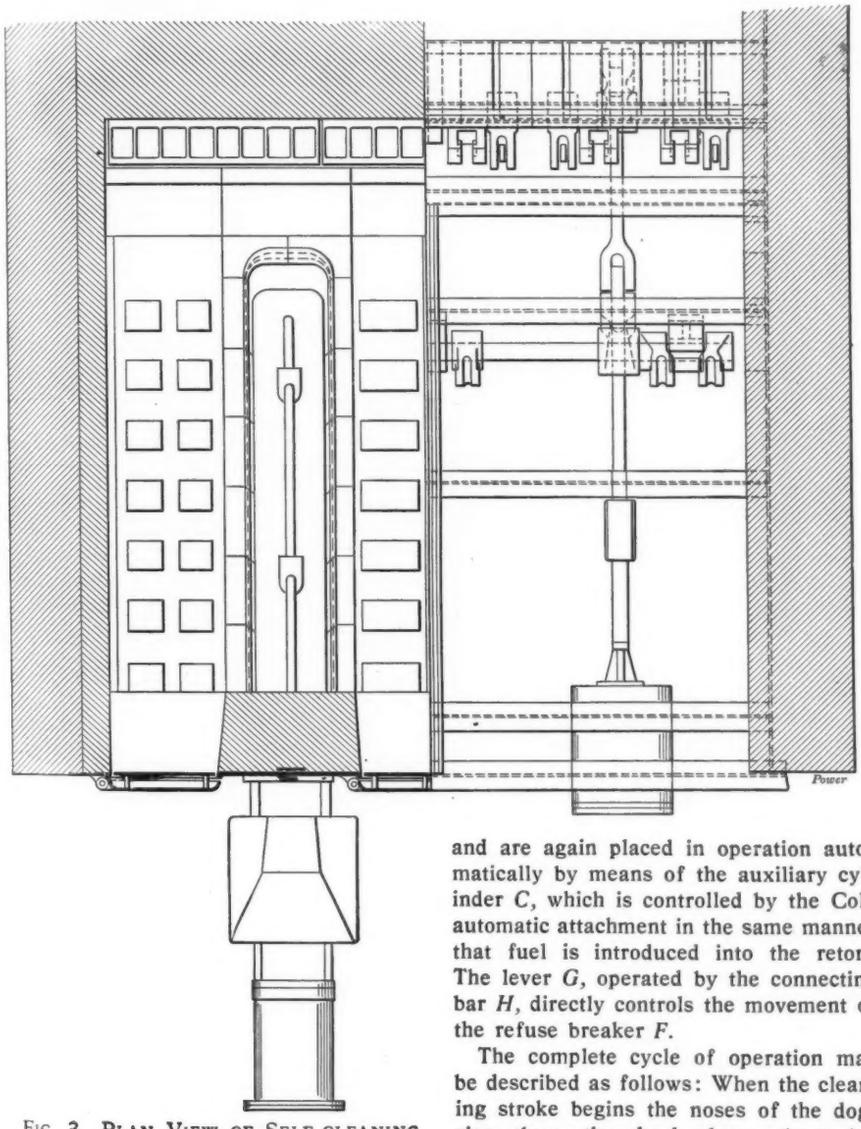


FIG. 3. PLAN VIEW OF SELF-CLEANING STOKER

by the auxiliary cylinder *C* there is a bar *D* connecting the lower portion of the dogs together to effect a movement of all the dogs in the dead plates in unison with the movement of the dead plates themselves. Each connecting bar *D* is moved by the lever *E*. The dogs *B* are for the purpose of giving an upward and a forward movement to the refuse which accumulates on the dead plates, thereby assisting the forward motion of the clinker at the time when the dead plates are moving longitudinally forward.

The refuse breaker *F*, at the rear of the stoker proper, is operated in exact unison with the dogs and the dead plates. The dogs, the dead plates and the refuse breaker begin operating at about the same time, the movement of the refuse breaker first being upward, so that the clinker which is farthest downward will extend beyond the end of the retort and dead plates and under the refuse breaker *F*. The parts above referred to having completed their upward and forward movement, return to the starting point and are again placed in operation automatically by means of the auxiliary cylinder *C*, which is controlled by the Cole automatic attachment in the same manner that fuel is introduced into the retort. The lever *G*, operated by the connecting bar *H*, directly controls the movement of the refuse breaker *F*.

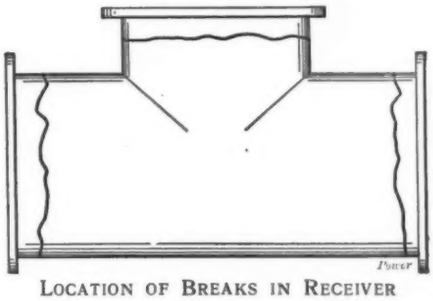
The complete cycle of operation may be described as follows: When the cleaning stroke begins the noses of the dogs rise above the dead plates about 1½ inches, facing the bridgewall. The dead plates themselves do not move until the dogs have risen to their extreme stroke, when the plates and dogs referred to move forward to the end of their travel, and carry the refuse a predetermined distance. The upward movement of the refuse breaker having been completed when the dogs and dead plates are at their forward position, then begins its downward stroke, carrying with it to the ashpit such refuse as may not have fallen therein, the dead plates and dogs returning to their original position. These movements are all accomplished by one forward and one backward movement of the auxiliary-cylinder piston. Fig. 3 shows a plan view of the stoker.

The increased fuel capacity of the self-cleaning stoker is not due to the self-cleaning attachment, but is due to the fact that the retort is materially longer than the standard retort; the tuyere area is, therefore, greater and in addition the tuyere blocks are made of greater hight, therefore containing greater air outlet. In other words, the tuyere area of the self-cleaning stoker, due to its greater length and greater air-outlet space in the tuyere blocks, has been increased fully 200 per cent., it is claimed.

The builders also state that with two of these self-cleaning stokers a smokeless consumption of 7000 pounds of bituminous coal per hour has been obtained in a water-leg furnace 5 feet 6 inches wide by 8 feet long, this consumption being at the rate of 160 pounds of coal per square foot of furnace surface per hour.

Receiver on Large Cross-Compound Explodes

On September 16, at 5:20 a.m., at the Harvard station of the Boston Elevated Railroad Company, in Cambridge, Mass., the attendant had completed the preparations for starting a 2700-horsepower vertical cross-compound condensing engine and was standing at the throttle when the receiver between the high- and the low-pressure cylinders exploded. The concussion blew out all the windows at one end of the building. The receiver dropped,



LOCATION OF BREAKS IN RECEIVER

carrying with it a considerable part of the valve gear, and crashed through the concrete floor, landing in the basement.

The receiver was made of two cast-iron cylinders, 8 feet long, 3½ feet in diameter and about 2 inches in thickness; only one of these was damaged. It was equipped with a spring-loaded safety valve. It failed in three places, the middle flange casting and about 1 or 2 inches from the end flanges.

From observations and the little that could be drawn from the attendants, it is thought that the receiver failed from too high pressure, caused either by warming the cylinders preparatory to starting, or possibly from a leak in the reheater coil and the failure of the safety valve to operate. It is suggestive that one of the attendants said that more than one safety valve would be placed on the new receiver that is being installed.

Safe Working Rule for Belts

In *Phoenix*, a publication issued by the New York Leather Belting Company, Samuel Webber, of Manchester, N. H., gives some interesting data on the transmission power of belts which is worthy of repetition.

"I have had a working rule for many years, which was given to me by an old and experienced machinist, and may be thus expressed: Ordinary leather belting 1 inch wide, having a velocity of 600 feet per minute, will transmit one horsepower.

"Practice has shown me the safety of this rule, for which I have sought a reason and a formula.

"After an examination of the textbooks, I found that Morin's data gave me the clue to the truth of this rule, and that it was supported by other good authority. Morin says: 'Belts designed for continuous service may be made to bear a tension of 0.551 pound per 0.00155 square inch of section, which enables us to determine their breadth according to the thickness.' This is equal to 355 pounds per square inch of belting leather, and it is also equal to from ⅛ to 1/12 the breaking strength of the same, as given by Rankine and other authorities.

"From this I see my way to a simple formula: Substituting 330 pounds for 355 pounds per square inch, I strike the component part of a horsepower and deduce the following: One square inch of belting, at a velocity of 100 feet per minute, will transmit one horsepower with safety, and from these data get this rule:

"The denominator of the fraction expressing thickness of the belt in inches gives the velocity in hundreds of feet per minute at which each inch of width will transmit one horsepower.

"Thus

$$\frac{1}{6} = 6 \times 100 = 600 \text{ feet; } \frac{1}{3} = 3 \times 100 = 300$$

feet, and so on.

"Now, ⅙ inch being about the ordinary thickness of a single belt, this shows me why my 'old rule of thumb' proved right, and a careful examination of many of the large belts running in our New England cotton mills within the last year or two confirms my opinion as to the safety of the rule.

"This gives a strain of 55 pounds per inch, and a belt speed of 50 square feet of surface per minute per horsepower as safe, ordinary practice for single belts; and I find the same velocity, with a strain proportioned to the thickness, works well with double belts. This, however, is applicable where there is a sufficient holding surface on the smaller pulley, if the arc of contact be small, a wider belt will be necessary, and I am not yet able to formulate a rule for belt contact. The nearest approach that I have made to it yet is to allow 10 to 12 square inches of pulley surface in contact with belt for each horsepower.

"It is generally conceded that the friction of a belt passing half around a pulley, is equal to one-half the strain on the belt; or that an inch belt, at 600 feet per minute, with a strain of 55 pounds would give a traction of 27.5 pounds and require a pulley which would give 1200 lineal feet per minute of surface contact, to obtain the horsepower to which the belt would be equal.

"The friction of a belt varies with the arc circle of the pulley with which it is in contact, and is only half as great on one-quarter of a pulley as on one-half of one; so that double the surface in square inches will be needed in the latter.

"Carrying out these rules, it will easily be seen that where high speed is to be obtained by the use of small pulleys, a much greater width of belt is necessary to get the frictional surface than is called for by the strength of the leather."

National Conservation Congress

At the second national conservation congress, held in St. Paul, Minn., September 5-9, 1910, President William H. Taft opened the congress and ex-President Theodore Roosevelt in his speech on the following day emphatically urged that the Federal Government retain control of water-power sites as well as coal lands and forests. Other speakers, among them James J. Hill, urged that these resources be left to the control of the individual States, believing the national machine to be too large and too remote and its operation too slow, cumbrous and costly.

The congress concluded its deliberations by adopting a platform in which it declared the rights of the people "to be natural and inherent and justly inalienable and indefeasible" and that these resources must be "developed, used and conserved in ways consistent both with current welfare and the perpetuity of our people." It further declared that the waterways should be administered in the interests of all the people, and that in doubtful cases there should be coöperation between State and Federal agencies; that use of the waters should be made with reference to all other uses and care be taken to prevent defilement; that the policy with regard to swamp lands be continued and extended; that a Federal commission empowered to deal with all water powers be maintained; that public lands be withdrawn pending classification and surface rights be separated from mineral, forest and water rights; that mineral lands be leased for a limited period; and that national forests be controlled by the Federal Government and the forestry service be given larger appropriations. The congress further expressed itself as opposed to child labor as detrimental to the life and development of the people physically, intellectually and morally, and recommended legislation suitable to this end.

A. S. M. E. Meetings in New York and Boston

The first meeting of the American Society of Mechanical Engineers for the coming season will be held in the Engineering Societies' building, New York, on Tuesday evening, October 11. The paper will be by Frank B. Gilbreth on "Fires: Effects on Building Material and Permanent Elimination." This paper was published in *The Journal* for May.

Meetings of the society in Boston are announced for October 19, November 11 and December 23. The October meeting will be conducted by the Boston Society of Civil Engineers, the American Society of Mechanical Engineers and other engineering societies of the city coöperating. The subject will be "An Account of the Destruction of Carthego, Costa Rica, by the Earthquake of May 4, 1910."

The November meeting will be conducted by the American Society of Mechanical Engineers and the December meeting by the Boston section of the American Institute of Electrical Engineers. It is expected that the meeting in January will take the form of a dinner of the character of the one held last January, at which there were some five hundred in attendance, representing the various engineering and architectural societies of Boston and vicinity and many of the technical schools and other organizations.

The annual meeting of the society will be held in New York, December 6-9, 1910.

Board of Education Public Lectures

In the new season of free public lectures for adults which was opened by the Board of Education, of New York City, on Saturday evening, October 1, special emphasis has been laid upon technical subjects, such as will appeal to workmen and to students in the technical trades. Of first importance is the course on "Power" to be delivered by Dr. Charles E. Lucke, professor of mechanical engineering at Columbia, who will give eight lectures on the topic on Saturdays at St. Bartholomew's hall, 205 East Forty-second street, beginning on October 1. His first lecture will consider "Mechanical Power and Machinery."

On October 4, at Public School 63, Fourth street, east of First avenue, R. J. Newton Gray, of the Manual Training High School, began a course of eleven lectures on "Physics," while on October 6, at St. Luke's hall, Hudson and Grove streets, Dr. Frederick E. Breithut, of the College of the City of New York, opened a course of eleven lectures on "The Chemistry of Common Things." On October 10, at the Stuyvesant High

School, Sixteenth street, near First avenue, Dr. William L. Estabrooke will give the first of his course on "Inorganic Chemistry."

During November, Prof. Bradley Stoughton, of Columbia, will deliver a course on "The Metallurgy of Iron and Steel" at Cooper Union and also at Institute Hall, 218 East One Hundred and Sixth street. While in December, Prof. Charles E. Pellew will give a course of lectures on "Dyeing" at St. Luke's hall.

In the Bronx, at Lafayette hall, Alexander avenue and One Hundred and Thirty-seventh street, on October 3, W. Wallace Ker, of the Hebrew Technical Institute, opened a practical course on "Principles and Practice in Electrical Engineering."

PERSONAL

Announcement is made of an important change in the management of the Goldschmidt Thermit Company, 90 West street, New York. On October 1, E. Stutz, vice-president and general manager, retired from the direction of the company, which passed under the management of William C. Cuntz. Mr. Cuntz brings to his position a thorough knowledge of the steel business and a wide acquaintance with the railway and street-railway officials of the country, having been connected for eighteen years with the Pennsylvania Steel Company.

BOOKS RECEIVED

KENT'S MECHANICAL ENGINEERS' POCKET-BOOK. Revised. By William Kent. John Wiley & Sons, New York. Morocco leather; 1461 pages, 6¾x1¼ inches; 218 illustrations. Price, $5.

THE CONSTRUCTION OF GRAPHICAL CHARTS. By John B. Peddle. McGraw-Hill Book Company, New York. Cloth; 109 pages, 6¼x9½ inches; 58 illustrations. Price, $1.50.

DESIGN OF MARINE MULTITUBULAR BOILERS. By James D. McKnight and Alfred W. Brown. The Technical Publishing Company, Ltd., London, England. Cloth, 48 pages; 6⅜x10 inches; illustrated. Price, $1.50.

HEAT ENGINES. By John R. Allen and Joseph A. Bursley. McGraw-Hill Company, New York. Cloth; 288 pages, 6¼x9½ inches; 157 illustrations. Price, $3.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

ROTARY ENGINE. William M. Hoffman, Buffalo, N. Y., assignor to Frank B. Allen, Toronto, Canada. 971,043.

ELASTIC FLUID TURBINE. Carl Richard Waller, Trenton, N. J., assignor to De Laval Steam Turbine Company, New York, N. Y., a Corporation of New Jersey. 971,092.

STEAM ENGINE. Georje Psareas and Nick Parkas, Holyoke, Mass. 971,402.

TIDE MOTOR. Daniel M. Barr, Philadelphia, Penn. 971,343.

BOILERS, FURNACES AND GAS PRODUCERS

GAS PRODUCER. William B. Hughes, Cleveland, Ohio. 971,271.

GAS PRODUCER. William B. Hughes, Cleveland, Ohio. 971,272.

BOILER. Ferdinand W. Meyer, Kansas City, Mo. 971,296.

FURNACE. Peter Stipp, Scranton, Penn. 971,416.

POWER PLANT AUXILIARIES AND APPLIANCES

FLUID PRESSURE REGULATOR. Max Jaspersen, Hamburg, Germany. 971,275.

CUTOFF VALVE. Morgan D. Menear and Charles O. Shay, Independence, W. Va. 971,295.

CARBURETER. Edward J. Gulick, Mishawaka, Ind., assignor to the Simplex Motor Car Company, Mishawaka, Ind., a Corporation of Indiana. 971,038.

CONTROLLING VALVE FOR FLUID OPERATED MOTORS. Charles Algernon Parsons, George Gerald Stoney, Alfred Quintin Carnegie and Albert William Bowerbank, Newcastle-upon-Tyne, England; said Stoney, Carnegie and Bowerbank assignors to said Parsons. 971,069.

ROTARY PUMP OR AIR COMPRESSOR. George R. Gether, Milwaukee, Wis. 971,188.

FURNACE DOOR. Gustav de Grahl, Zehlendorf, near Berlin, Germany. 971,266.

STEAM AND WATER GAGE. Edward Halley, Chicago, Ill., assignor of one-half to R. J. McDonell, Victoria, British Columbia, Canada. 971,268.

PISTON-ROD PACKING. Frank N. Mason, Pittsburg, Penn. 971,292.

COOLING DEVICE FOR INTERNAL COMBUSTION ENGINES. Ralph Brooks Vaughn, Wilkes-Barre, Penn. 971,328.

BOILER FEED-WATER REGULATOR. Howard E. Cade, Pencoyd, and David R. Knapp, Philadelphia, Penn. 971,357.

DEVICE FOR FACILITATING THE REMOVAL OF ENGINE VALVES. Oliver A. Hays, Southampton, N. Y. 971,375.

STEAM-PRESSURE REDUCING AND CONTROLLING VALVE. Nicolas Filiberto, Brooklyn, N. Y. 971,435.

ENGINE GOVERNOR. Charles B. Edwards, Massillon, Ohio, assignor of one-fourth to John H. Crooks and one-fourth to William Simonet, Massillon, Ohio. 971,431.

THERMOSTATIC OIL CUP. Edwin J. Grant, Sandy Point, Me. 971,440.

STOP VALVE. Charles O. Hawkins, Chesterhill, Ohio. 971,446.

VALVE MECHANISM FOR COMPOUND ENGINES. Paul Oluff Poulson, Brigham, Utah. 971,472.

STARTER FOR INTERNAL COMBUSTION ENGINES. David Smith Anthony, Durango, Mexico, assignor of one-third to Edward Williams, and one-third to George F. Habernigg, Durango, Mexico. 971,482.

STEAM CONDENSER. Henry L. Brandon, Leavenworth, Kas. 971,486.

HYDROCARBON BURNER. Willis W. Case, Sr., Denver, Colo., assignor to the Denver Fire Clay Company, Denver, Colo., a Corporation of Colorado. 971,489.

APPARATUS FOR REMOVING GASES AND VAPORS FROM SURFACE CONDENSERS. Emil Josse, Berlin, and Wilhelm Gensecke, Charlottenburg, Germany. 971,505.

ELECTRICAL INVENTIONS AND APPLICATIONS

SYNCHRONOUS INDUCTION MOTOR. Carl A. Lohr, Chicago, Ill. 971,056.

CIRCUIT BREAKER. Frank L. Sessions, Columbus, Ohio, assignor, by mesne assignments, to the Jeffrey Manufacturing Company, a Corporation of Ohio. 971,082.

SYSTEM OF MOTOR CONTROL. Leopold Janisch, Berlin, Germany, assignor to General Electric Company, a Corporation of New York. 971,199.

PORTABLE ELECTRIC LIGHT. Joseph Block, New York, N. Y. 971,241.

ELECTRIC RAILWAY SAFETY SYSTEM. Antonio Casale, Scranton, Penn. 971,249.

SAFETY LIMIT SWITCH. William W. Pierce and George A. Pierce, Philadelphia, Penn. 971,307.

INCANDESCENT ELECTRIC LAMP. Anton Lederer, Atzgersdorf, near Vienna, Austria-Hungary, assignor to Westinghouse Lamp Company, Bloomfield, N. J., a Corporation of Pennsylvania. 971,453.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., W. W. Freeman, Brooklyn, N. Y.; sec., T. C. Martin, 31 West Thirty-ninth St., New York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next annual meeting at Chicago, Oct. 10-13, 1910.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power and the Engineer.

One hears about thought transference—about projecting one's thoughts into another man's mind—and marvels.

As a trick or amusement it can't be equalled—

As an adjunct to a modern business it isn't worth one iota.

One cannot employ a telepathist to project a thought—without words—to 30,000 or 40,000 people, at so much per projection.

One cannot "wish" a man into buying anything without giving him some tangible "reasons why."

Yet there are manufacturers who unconsciously seem to have this idea.

They think that because *they* know a thing to be so—that their knowledge naturally is common knowledge.

They think that because they make a good device the world will become aware of it without their going to any trouble telling about it.

But this class of manufacturer is rapidly becoming converted—he is gradually coming to see that the only way to reap a real harvest is to harness modern methods to his business.

The bulk of the manufacturers of power-plant devices *know* that the power-plant man buys only upon solid, can't-get-away-from facts.

They know that power-plant men do their own thinking, that they do their own selecting, and that when they select, it is only because the device in question has been proven to be one they need—

For the saving it will effect, or for the improved work it will help accomplish.

And consequently these manufacturers tell you, in the Selling Section of your paper, the points that make their devices better, more serviceable, more economical.

They *show you* why their goods *should* be used, and they let *you* be judge as to whether or not their goods should be used in *your* plant.

These are the manufacturers who are "reaping the harvest."

They tell their stories in such a way that you can't help but get valuable ideas from them.

They put you in the way of thinking up ways and means of lessening expenses, and increasing efficiency—

Which means progress for you *personally*.

These are manufacturers you should listen to with much attention.

Their talks are meaty, full of real arguments—they do not depend upon "mental telepathy" to sell their goods—

They have the "reasons why" and are not afraid to tell them to *you*.

Go through this Selling Section carefully and prove these things to your own satisfaction.